SCIENCE EDUCATION

CHARLES EDGAR MONTGOMERY

VOLUME 44 MARCH, 1960 NUMBER 2

SCIENCE EDUCATION

THE OFFICIAL ORGAN OF

National Association for Research in Science Teaching
Council for Elementary Science International
Association on the Education of Teachers in Science

CLARENCE M. PRUITT, EDITOR
University of Tampa
Tampa, Florida

Manuscripts and books for review as well as all communications regarding advertising and subscriptions should be sent to the Editor.

SCIENCE EDUCATION: Published in February, March, April, October, and December.

Subscriptions $5.00 a year; foreign, $6.00. Single copies $2.00; $2.50 in foreign countries. Prices on back numbers furnished upon request.

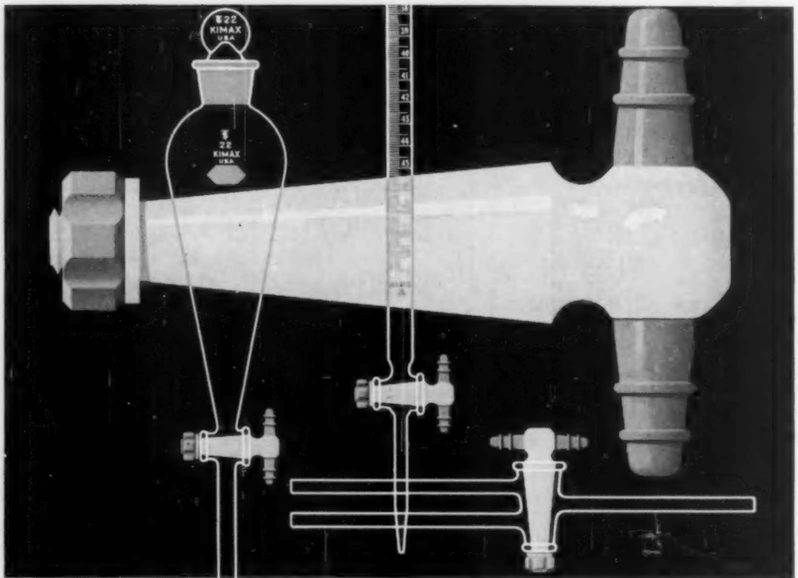
Publication Office: 49 Sheridan Avenue, Albany 10, New York

Second class postage paid at Albany, N. Y.

VOLUME 44 MARCH, 1960 NUMBER 2

CONTENTS

(Continued on page 156)



SCIENCE EDUCATION

VOLUME 44 MARCH, 1960 NUMBER 2

CHARLES EDGAR MONTGOMERY

HOOSIER-BORN, farm-reared, Charles Edgar Montgomery is recipient of the Twentieth Science Education Recognition Award. His parents spent all of their active lives on a farm. The grandfather, Samuel Montgomery, came to Indiana on horseback from Virginia with nine brothers and one sister in the early 1800's. Most of them settled and entered land in a semicircle bending to the west of Indianapolis. From this area younger generations of Montgomerys have spread to Illinois, Iowa, Kansas, and other western states. The father, James Samuel, was born in 1847 at the tail-end of the log-cabin era. Log cabins, log barns, log school houses, log churches, and big open fireplaces were then common. Life was simple and social contacts few. This early training was reflected in many ways in the early married life of Dr. Montgomery's parents and was transferred to the children. The mother, Sarah Jane Jordan Montgomery, was born in 1862. Her father came to America from Ireland and her mother came from Maryland, both settling in Brownsburg, Indiana, after their marriage. Dr. Montgomery was born on a farm near Danville, Indiana, January 17, 1884. Here he grew up and received his elementary school and high school education. He attended a one-room elementary school, graduating by examination in 1898. Entering nearby Avon High School in September 1898, he graduated in 1901, having had only three years of high school. This was a one-room, one-teacher high school. The teacher is described by Dr. Montgomery as being "tops and the chief inspiration for my continuing higher education in colleges and universities." He entered the Indiana State Normal School at Terre Haute in the Winter Quarter (January) 1902. During this period it was the popular thing to go to college until a license to teach in the elementary schools could be obtained, teach during the six-months school term, then go back to college for the spring term beginning in April. After teaching two years in a one-room rural school Dr. Montgomery went back to Indiana State Normal School for two years (1904–1906), taught for three more years, and back to Indiana State Normal School for the year 1909–10, graduating in 1910. Entering the University of Chicago in the summer of 1912, he graduated with a B.S. in Education in March, 1913. Entering Purdue University in the fall of 1916, he received an M.S. degree in 1918. A Ph.D. degree, with a major in Botany, was earned at the University of Chicago in 1930. Post-doctorate work was taken at the University of Chicago, University of Michigan, the University of Denver, and the University of Virginia.

Teaching experience has been as follows:

Hendricks County, Indiana, one-room rural school, 1902–04; New Winchester Indiana, High School, principal and teaching high school mathematics, latin, history, economics, coaching basketball and football, 1906–09; Marion, Indiana, High School, teaching biology and coaching basketball, 1910–12; Bloomington, Indiana, High

School, teaching botany and serving as botany critic teacher for Indiana University, 1913–16; Purdue University, Lafayette, Indiana, half-time teaching fellow, 1916–17; Northern Illinois State Normal School, De Kalb, Illinois, teaching biology and agriculture, 1917–18; Training School, Northern Illinois State Normal School, principal, 1918–20; Head of Department of Biology, Northern Illinois State Normal School (later Northern Illinois State University), 1920–until retirement in 1952. The Normal School became a four-year Teachers College in the early '20's, granting the B.S. degree in Education.

After teaching courses in Nature Study, Agriculture, Hygiene and Zoology in the Normal School, Dr. Montgomery initiated the development of more advanced courses in biology when the normal school became a teachers' college. The problem was to build a major that would prepare students to teach high school and at the same time prepare students to enter universities and take graduate work without loss of credits. As in many similar instances, this involved teaching many small classes, teaching many extra hours, giving special help. During this time, field courses were developed and much attention paid to outdoor study, especially with birds and prairie vegetation. Courses taught in college include botany, zoology, biology, bacteriology, histology, genetics, evolution, and the teaching of biology.

Commenting on college growth and the corresponding growth in the science department, Dr. Montgomery says, "As Northern Illinois State Normal School grew, the department grew, which meant an increase in the number of members of the department. It expanded from two in the late 20's to eight by 1950. This was a loyal and energetic group of young men, each of whom as he came on the scene assumed his responsibilities with unreserved enthusiam. Any credit for the development and standing of the department in the college and among the colleges must be proportionately shared with each member. The department made a serious effort to give to each student a thorough background in detailed fundamentals of subject matter and this coupled with an aggressive attitude and a virule enthusiasm for work has not only drawn many young people into the field of science but has induced them to go on into places of higher learning. If there is any feature of this work about which the department and the college can be proud it is the fact that a goodly number of these young people are today making worthwhile contributions in the field of science, ranging from the grades, through high school and into colleges and universities. To a high degree, the goal of building a biology department to a high standard second to none in the country has been attained."

Dr. Montgomery married Frances Idella Snyder, daughter of Mr. and Mrs. F. M. Snyder, at Lafayette, Indiana, September 1, 1909. The Montgomerys were the parents of three children: Jean Elizabeth (Mrs. Duane L. Griffith), 11313 W. Parkway, Detroit, Michigan. She is a teacher in kindergarten and has two children, a daughter Nancy who is a sophomore in Ottawa College, Ottawa, Kansas, and a son Donald, a student in a Detroit Junior High School. Carol Frances (Mrs. Richard Jarvis), is deceased. She had two sons, David now married with two sons of his own and Robert, a sophomore in the Lansing, Michigan, High School. Ellen Jane (Mrs. Milton Lomas), lives at 11672 Gary Street, Garden Grove, California. She has four boys, three (Michael, Marcus, and Charles) in grade schools and one, Jeffry, starting kindergarten next fall. Thus the Montgomerys have seven grandsons, a granddaughter, and two great-grandsons. The Montgomerys are members of the Methodist Church but have at times affiliated with the Christian and Congregational churches.

Publications include his doctoral study "Mosses of the Grand De Tour Region" published in the *Botanical Gazette,* short articles in *School Science and Mathematics* and the *Illinois Academy of Science Bulletin.* The title of his Master's thesis at

Purdue University was "Teaching Botany in Indiana High Schools." It was a survey of conditions then prevalent in Indiana high schools. During the years many resource units, bibliographies, laboratory direction sheets, bulletin, etc., were prepared for class use but were never published.

Membership in organizations include the National Association for Research in Science Teaching (Life), Indiana Academy of Science, Illinois Academy of Science, Central Association of Science and Mathematics Teachers, Illinois Teachers Association, National Education Association, Indiana Teachers Association, National Association of Biology Teachers, American Association for the Advancement of Science, American Association of University Professors, Phi Delta Kappa, Rotary, Sigma Xi. Dr. Montgomery is listed in *Leaders in American Science* and *Who's Who in American Education.* He considers possibly his greatest honor the naming of the campus woods at Northern Illinois State University "The C. E. Montgomery Arboretum" by the College Board.

Commenting on his teaching experiences, beliefs, and philosophy, Dr. Montgomery says:

> Teaching and learning are two of the oldest activities connected with the processes of living. Years of research have been spent and volumes of literature have appeared on these fundamentals. Much good has been accomplished and some progress made by this research but to date we still know relatively little about what goes on inside human beings that make them behave as they do. Emotions offer a clue and I found people could make better use of them if they were taught how to do so. In my way of thinking, it is about as important to teach persons to like to work as it is to give them heavy tasks to carry out. They will not only do more work if they like it, but will actually retain it longer and make more substantial progress. Along this same line, I would not retain a teacher in the classroom long who habitually lost his temper and created antagonism in a learning situation.
>
> My studies led me to set out the following items that are good aids to a teacher in the performance of his duties:
>
> 1. Familiarity with subject matter.
> A teacher should be able to carry through a lecture, recitation, quiz, or whatever the exercise without aid of a book, notes, or other types of assistances. He should know the subject matter at hand far beyond the reach of the students and that should hold all of the way to the graduate level.
> 2. Excitement.
> Inasmuch as the teacher is the leader, it is very essential that he learn to become excited when in the teaching situation. It is like throwing the body into high gear and releasing a lot more energy. It is a higher emotional state and results in a more pleasant exercise as well as a more profitable one.
> 3. Student cooperation.
> The teacher should not only elevate his own excited state but should get the students to do the same thing. The response as a result becomes positive and the students give a greater amount of energy to the learning task at hand. Enthusiasm by the teacher carries over into the student's attitude and habits.

The writer has never had the pleasure of knowing Dr. Montgomery personally, but we are proud that such a noted teacher is a fellow Hoosier. Dr. Loren T. Caldwell, a long-time colleague of Dr. Montgomery, made these comments to the writer at the recent Chicago meeting: Dr. Charles Montgomery was a teacher of biology who taught students as he taught biology. The chemistry and physics of biological ecologies came into focus as he taught. He was a young-in-mind teacher when he retired from teaching at the age of 68. His very great love for nature *was* and *is* demonstrated by his well-husbanded flower and vegetable gardens. On field trips and picnics, "Monty" was as interested in all aspects of all sciences as he was in living biology. Many of Monty's former students have become noted leaders in biological and medical research, and in teaching science. His great patience with slow students carried with it the spark of understanding which changed many potential failing students into above-the-average science students. It is more than complimentary to have his students remember him voluntarily as their best teacher. A one thousand student poll at Northern Illinois State Teachers College selected "Monty" as the most popular teacher in the college.

Dr. Montgomery and Mrs. Montgomery now live at 12531 Jane Drive, Garden Grove, California where his life time hobbies of gardening, living in the out-of-doors, and traveling keep him well occupied. He says he now has time to catch up on some reading he has always wanted to do and that although their health is not too much better, it is a lot easier to live in California than in the more rugged mid-west.

It is with great pride that the Twentieth Science Education Recognition Award is made to Charles Edgar Montgomery, outstanding science classroom teacher, beloved alike by his students and his colleagues.

CLARENCE M. PRUITT

A new bibliography of *Paperbound Books in the History and Philosophy of Science* has been prepared as a guide for high school science teachers. This 16-page, mimeographed bibliography lists approximately 200 titles and includes an estimate of the difficulty of the content and language of each book. High school science teachers may obtain a copy of the bibliography by sending a request to the compiler, Leo. E. Klopfer, 75 Batchelder House, Harvard Graduate School of Education, 7 Kirkland Street, Cambridge 38, Mass. Please enclose 10¢ to cover mailing expenses.

o. 2
nia
eth
is
ut-
ved
ies.
r

PROGRAM OF COUNCIL FOR ELEMENTARY SCIENCE INTERNATIONAL

In Collaboration with Association for Supervision and Curriculum Development

SHERATON-GIBSON HOTEL, CINCINNATI, OHIO

February 28–March 1, 1959

SCIENCE IN THE ELEMENTARY SCHOOL CLASSROOM

9:00– 9:30 Registration—Roof Elevator Foyer
9:30–11:30 General Session—Roof Garden Foyer

Presiding: Willard J. Jacobson, Teachers College, Columbia University, President, Council for Elementary Science International

Welcome: Claude V. Courter, Superintendent of Schools, Cincinnati Public Schools, Cincinnati, Ohio

"Science in an Elementary School Classroom," Irene M. Lammers, Westwood School, Cincinnati, Ohio

"Science in an Elementary School Classroom," John Grate, Cincinnati Public Schools, Cincinnati, Ohio

"Science in an Elementary School Classroom," Ullainee Downing, Cincinnati Public Schools, Cincinnati, Ohio

"Implications for Elementary School Science," Katherine Hill, Associate Professor of Education, New York University, New York, N. Y.; Lewis D. Evans, Assistant Professor of Elementary Science Education, Ohio State University, Columbus, Ohio

Discussion from the floor

12:00– 1:45 Luncheon—Main Roof Garden

Presiding: John Navarra, Jersey City State College, Vice President, Council for Elementary Science International

Address: Bernard B. Berger, Chief, Water Supply and Water Pollution Program, Robert Taft Sanitary Engineering Center, Cincinnati, Ohio

2:00– 3:45 Group Discussion

Discussion Group I

"Science in Our Local Communities"—Parlor 4

Discussion Leader: G. Marian Young, Associate Professor of Education, University of Florida, Gainesville, Florida

Recorder: Irene Lammers, Westwood School, Cincinnati, Ohio

Resource Persons: Selma Widerschein, Natural History Museum, Cincinnati, Ohio; George Crawford, Supervisor of Curriculum, Maryland State Department of Education, Baltimore, Maryland

Discussion Group II

"Experiments and Demonstrations in Elementary School Science"—Parlor 5.

Discussion Leader: Grace Maddox, Supervisor of Science, Cleveland, Ohio

Recorder: Ullainee Downing, Cincinnati Public Schools, Cincinnati, Ohio

Resource Persons: Sherman Davis, Douglas Elementary School, Cincinnati, Ohio; Audrey Childress, Madisonville Elementary School, Cincinnati, Ohio; Lucille Illbrook, Madisonville Elementary School, Cincinnati, Ohio

Discussion Group III

"Projects in Elementary School Science"—Parlor 6

Discussion Leader: Peter Dean, Associate Professor of Science Education, Wayne State University, Detroit, Michigan

Recorder: David Hessong, Assistant Professor of Education, Miami University, Oxford, Ohio

Resource Persons: Isabelle Cropper, Highlands Elementary School, Cincinnati, Ohio; Florence Lanning, North Fairmount Elementary School, Cincinnati, Ohio; Anna Marie Karches, Bond Hill Elementary School, Cincinnati, Ohio

Discussion Group IV

"Problems in Developing Elementary Science"—Parlor 7

Discussion Leader: Cecilia Lauby, Professor of Education, Illinois State Normal University, Normal, Illinois

Recorder: Calvin Berliner, Cincinnati Public Schools, Cincinnati, Ohio

Resource Persons: Janet Biltz, Clifton Elementary School, Cincinnati, Ohio; Dorothy Clason, Taft Elementary School, Cincinnati, Ohio

4:00– 5:00 General Meeting—Sheraton Room

Presiding: Willard Jacobson

Further discussion of "Implications for Elementary School Science"

SUNDAY, MARCH 1

9:30 Annual business meeting of the Council for Elementary Science International. (Room to be assigned.)

Leah Carr, Supervisor, Intermediate Grades, Cincinnati Public Schools, was the local chairman for this meeting.

Willard Jacobson of the Council for Elementary Science International arranged the program.

COUNCIL FOR ELEMENTARY SCIENCE INTERNATIONAL

What Is It?

The Council for Elementary Science International is an organization for improving science teaching in the elementary school of the nation.

What Are Its Purposes?

To promote a science curriculum for the elementary grades which will be a part of the continuous and integrated science program for the entire school.

To promote study of problems involved in the methods and techniques of science teaching in the elementary school.

To further the pre-service and in-service education of teachers for teaching science in the elementary school.

Who Belongs to the Council?

Elementary classroom teachers, supervisors, college instructors, and other persons interested in working at the local, state, or national level to improve science teaching are members of the Council.

How Can I Join?

You can join by sending the annual dues of $2.00 to John McLain, South Milwaukee Public Schools, 2420 15th Avenue, South Milwaukee, Wisconsin.

PROGRAM OF COUNCIL FOR ELEMENTARY SCIENCE INTERNATIONAL

IN COLLABORATION WITH THE ASSOCIATION FOR CHILDHOOD EDUCATION INTERNATIONAL

HOTEL JEFFERSON, ST. LOUIS, MISSOURI

APRIL 3, 1959

IMPROVING INSTRUCTION IN ELEMENTARY SCIENCE

Registration

9:00–11:00 A.M. General Session

Presiding: Willard Jacobson, President of the Council, Associate Professor of Science, Teachers' College, Columbia

Welcome: Philip J. Hickey, Superintendent of Schools, St. Louis, Missouri

Address:

(1) "A State Studies Its Curriculum," I. E. Ready, Director of the Curriculum Study, North Carolina State Board of Education

(2) "The Role of the Colleges in Curriculum Improvement," Joe Zafforoni, Assistant Professor of Education, Teachers' College, University of Nebraska

(3) "A Classroom Teacher Views the Problem," John E. Garone, Classroom Teacher, New York City Public Schools

12:00– 1:45 P.M. Luncheon

Presiding: John G. Navarra, Vice President of the Council, Chairman, Department of Science, Jersey City State College

Address: To be announced

G. Marian Young, Professor of Education, University of Florida, Gainesville, Florida

2:00– 3:45 P.M. Group Discussions

Group I

"Science—Its Role in Developmental and Remedial Reading"

Leader: Richard Hargrove, Teachers College, University of Oklahoma

Local Consultant: Dorothy Gorsuch, Elementary Consultant, St. Louis

Local Resource Person: Mary Field Schwarz, Teacher, Independence, Mo.

Participating Consultants: Kay Ware, St.

Louis; Christina Coy, Maplewood; Elinor Hayward, St. Louis; Margaret Press, Clayton; Glenys Unruh, University City

Group II

"The Contribution of Audio-Visual Media to the Science Program"

Leader: Lee Campion, Director, Audio-Visual Education, Co-operating Schools, St. Louis County

Local Consultant: Gertrude Hoffsten, Program Coordinator, Station KSLH

Local Resource Person: Esther Dornhoefer, St. Louis Schools

Participating Consultants: Eva Mckee, Normandy; Don Smith, Kansas City; Elizabeth Golterman, St. Louis; Richard Nibeck, Ferguson-Florissant School District

Group III

"How a School System Can Develop and Improve a Science Program"

Leader: Bernice Owens, North Texas State College

Local Consultant: Claire Brewer, Principal, Springfield, Mo.

Local Resource Person: Marie Gaffron, St. Louis Schools

Participating Consultants: Alice Old, Horace Mann School; Anna Marie Wachal, Kansas City; Perry Henderson, Clayton

Group IV

"Keeping Abreast of Current Developments in the Field of Science"

Leader: Eleanor Johnson, Editor-in-chief, My Weekly Reader

Local Consultant: King Barnett, Principal, Webster Groves Schools

Local Resource Person: Gussie Fultz, Teacher, St. Louis

Participating Consultants: J. N. Vonckx, Normady School District; Theodore B. Curtis, Clayton; Raymond Roberts, Missouri State Director of Curriculum; Harrison Dugger, Brentwood; Lloyd Barnard, University City; Howell Goins, Webster Groves

Group V

"Action Research to Improve an Elementary Science Program"

Leaders: Patsy Montague, State Supervisor, North Carolina; Eloise Eskridge, Supervisor, Johnston County, North Carolina

Local Consultant: Jennie Wahlert, Washington University

Local Resource Person: Dorothy Pillman, St. Louis Public Schools

Participating Consultants: Carol Kahler, St. Louis University; John Whitney, Dean, Harris Teachers College; John Ervin, Harris Teachers College; Ellen Millman, Clayton; Fred Boercker, Webster Groves

4:00– 5:00 P.M. Closing Session

Presiding: Bonnie Howard, Supervisor of Instruction, Louisville Public Schools, Kentucky

Topic: "Where Are We Going in Elementary Science?"

The topic will be discussed by a panel which is evolved from among the group participants.

This program has been arranged by Dr. John Navarra of the Council and members of the Missouri State Committee: King Barnett, State Chairman; Jennie Wahlert, Claire Brewer, and Mary Field Schwarz.

OFFICERS AND BOARD OF DIRECTORS

President: Willard Jacobson, Associate Professor of Natural Sciences, Teachers College, Columbia University, New York 27, New York

Vice Pres.: John Navarra, Chairman, Department of Science, Jersey City State College, Jersey City 5, New Jersey

Sec.-Treas.: John McLain, Supervisor, Elementary Education, South Milwaukee Public Schools, South Milwaukee, Wisconsin

Board of Directors:

Muriel Beuschlein, Science Department, Chicago Teachers College, Chicago, Illinois

Gerald S. Craig, Professor Emeritus of Natural Sciences, Teachers College, Columbia University, New York 27, New York

Bonnie Howard, Board of Education, Louisville 2, Kentucky

Albert Piltz, Supervisor for Elementary Science, Detroit Public Schools, Detroit, Michigan

Ruth Roche, Assistant Professor of Elementary Education, Los Angeles State College, North Ridge, California

Joe Zafforoni, Assistant Professor of Education, University of Nebraska, Lincoln, Nebraska

1958–1959 REPORT FOR COUNCIL FOR ELEMENTARY SCIENCE INTERNATIONAL

THE year 1959 was a landmark year for the Council for Elementary Science International. The Council continued its efforts to promote and develop science for children in elementary schools. This year, in addition to previous activities, the Council provided new membership services and sponsored its first meeting beyond the continental boundaries of the United States in Honolulu, the capital of Hawaii, the newest state in the Union.

As a part of its continuing service to all who are concerned with elementary school science, C.E.S.I. held four national meetings during 1959. A joint meeting with the National Association for Research in Science Teaching was held in Atlantic City to consider research papers in elementary school science. This meeting was arranged by Arnold Lahti of Western Washington College of Education. "Science in the Elementary School Classroom" was the theme of a meeting planned by Willard Jacobson of Teachers College, Columbia University, and held in Cincinnati in conjunction with the Association for Supervision and Curriculum Development. John Navarra of Jersey City State College planned the meeting held in St. Louis in collaboration with the Association for Childhood Education International. The theme of this meeting was "Improving Instruction in Elementary Science."

It was a distinct honor for C.E.S.I. to sponsor its first meeting in Hawaii. A three-day meeting was held around the theme "Exploring Problems in Elementary School Science." Albert Carr, Jr., of the University of Hawaii, developed the program.

Largely through the efforts of the secretary-treasurer, John McLain, a number of special services have been inaugurated for the membership. Several issues of the *Council for Elementary Science Newsletter* have been circulated. This newsletter gives information about the activities of the organization and items of interest about the activities of Council members. Copies of the *Elementary School Science Bulletin* published by the National Science Teachers Association and the elementary science issue of *Science Education* are distributed to members. The science department of Jersey City State College distributes the *Classroom Science Bulletin* to the membership of C.E.S.I. Also, reprints of articles pertaining to elementary science written by members are distributed from time to time.

During the year a proposal for the improvement of science instruction in the elementary schools of the United States was drafted. However, financial support for the project has not yet been obtained.

OFFICERS FOR 1959–1960

President—John Navarra, Chairman, Department of Science, Jersey City State College

1st Vice President—Ethleen Daniels, Elementary Supervisor, Rockville, Maryland

2nd Vice President—Arnold Lahti, Assistant Professor of Physical Science, Western Washington College of Education

Secretary-Treasurer—John McLain, Supervisor of Elementary Education, South Milwaukee, Wis.

Board of Directors

Muriel Beuschlein, Department of Science, Chicago Teachers College

Katherine Hill, Associate Professor of Education, New York University

Bonnie Howard, Board of Education, Louisville, Kentucky

Willard J. Jacobson, Associate Professor of Natural Sciences, Teachers College, Columbia University

Albert Piltz, Supervisor for Elementary Science, Detroit Public Schools

Ruth Roche, Assistant Professor of Elementary Education, Los Angeles State College

EXPERIMENTS AND DEMONSTRATIONS IN ELEMENTARY SCHOOL SCIENCE

DISCUSSION GROUP II *

EXPERIMENTS and demonstrations can be used in a variety of ways. It is sometimes valuable to use an experiment simply to arouse interest in Science itself. That is, to work an experiment that has no connection with the unit of work anticipated, as an attention getter, and as a means of stimulating curiosity to learn something new. An experiment might be set up for the children to work for the sheer pleasure of being able to do it themselves.

The experiment or demonstration may be used to open up a new area of work. It should grow out of the children's questions and problems and not merely be a demonstration or "show" for the teacher. Starting with a problem the teacher may work an experiment that solves the problem, but whenever possible children should discover how to work experiments by actually manipulating the materials themselves.

The experiment may be to answer a specific problem. Although a scientist in a true experiment is searching for an answer he doesn't know, in a classroom the teacher will know the outcome and will lead the children to that outcome by skillful questioning and direction. For the child, who did not know the results beforehand, this would in every sense of the word be a valid experiment.

There should be scope and sequence to the Elementary Science program so that concepts will be developed and expanded as the child travels from Kindergarten upward. There should be a course of study to eliminate the danger of making the Science program a "hodgepodge affair."

It is the teacher's duty to guide the thinking in a classroom so that the children follow correct scientific procedures and arrive at correct conclusions. If the proper scientific attitudes are developed in Science class, these same attitudes will be carried over into the other classes in the program. Children will use these principles to solve problems whether in Science, History, Mathematics, or any other area of work.

Since successful demonstrations need such a variety of materials, this group discussed ways of making equipment available to everyone in the school. They believed that there was a basic list of materials that every school should have. Some of the school systems have a list of standard equipment that can be ordered from a Central Office. Each teacher is given a Science Budget and may order for her classroom anything she wishes as long as she remains within the budget. Thus, over a period of years each classroom is well stocked. Other smaller schools have many ways of handling the school's equipment. There was the Science Table on wheels that was fully equipped with every Science need, including directions for use in case the teacher was not familiar with such equipment. The whole table could be rolled into a classroom and be used for demonstration purposes, since it was equipped with electrical outlets, Bunsen burner, etc., or it might be checked out drawer by drawer by more than one teacher at a time. This means careful scheduling so that each teacher may have what she needs when she wants it.

Another system was a Science Cart that had inexpensive 10¢ store materials, such as nails, screws, pins, marbles, etc., that could be rolled to the room where it was needed. A variation on this was a cart that was equipped with dry cells, magnets, bells, wire, etc. There was a cart provided for each floor in this building.

It was suggested that shoe boxes make ideal storing places. Materials can be sorted

* Leader: Grace Maddox, Supervisor of Science, Cleveland, Ohio. Recorder: Ullainee Downing, Cincinnati Public Schools, Cincinnati, Ohio.

into the boxes, labeled, and stored in a central place. Then the particular box that is needed can easily be carried to the room where it is needed.

Parents like to see what goes on in Science as well as any other field. Too often it is impossible to have something to "show." Whenever possible, therefore, materials that the children bring in should be used so that the things they make can be taken home.

ULLAINEE DOWNING

PROBLEMS IN DEVELOPING ELEMENTARY SCIENCE

DISCUSSION GROUP IV

One of the big problems many are facing deal with scope and sequence. Should we follow text books for scope and sequence in elementary science or should we establish areas to be developed at each level? If we do it by grade levels to develop each area further, will we not run into the problem of repetition which could destroy motivation? Many thought that to tell a fifth grade child this is all you are to learn this particular year was unrealistic and, in fact impossible. Rather than worry about scope and sequence it might be better to help a child develop the use of the scientific method. With this tool the child can be taught to solve his own problems and make his own conclusions. When we are concerned with what is to be taught at each level, should we not start with what research has told us rather than to begin anew?

Another problem that worried our group, concerned teacher training. What can be done to help a teacher learn content in this field and thereby gain some self-confidence in the class room? How can we acquaint teachers with what is going on and is being done in the field of elementary science? Membership in our organization certainly would be one method. Teachers new to elementary science are concerned because of insufficient time and knowledge, and the amount of work to be done.

Elementary science seems to be going through the same "growing pains" and problems that the other areas went through in their own growth and development. These areas solved their problems and elementary science will solve them.

CALVIN BERLINER

WHAT PREPARATION HELPS THE TEACHER TEACH FOR PERVASIVE OBJECTIVES? *

GROUP I REPORT †

1. What is critical thinking?
   a. THINKING as a *process of finding relationships* between two or more ideas, statements or situations.
   b. CRITICAL THINKING as the examination of these found relationships as well as examination of facts and basic assumptions.
   c. Thinking takes place *in the thinker*.

2. Specific aspects or objectives of critical thinking in schools and colleges.
   a. Illustrative or specific aspects or objectives of critical thinking to be adapted to all educational levels are the following suggestions from pages 176–7 in

* National Association for Research in Science Teaching—Council for Elementary Science International meeting, Hotel Dennis, Atlantic City, New Jersey, February 21, 1959.

† Leader: Brenda Lansdown, Brooklyn College, N. Y. Recorder: James Perlman, San Francisco State College.

Teaching Science in the Secondary School by R. Will Burnett.
1. Discover problem situations.
2. Delimit problems into workable and procedural proportions.
3. Develop critical hypotheses.
4. Secure relevant, authoritative reference data expeditiously.
5. Secure experimental or observational data critically and expeditiously.
6. Recognize the bases of authority.
7. Work co-operatively.
8. Recognize personal bias and consider it in making judgments.
9. Allow ascertainable facts to speak louder than prejudice.
10. Communicate effectively with accuracy.
11. Recognize the limitations of both data and conclusion.
12. Reopen issues with new data as available.
13. Recognize the approximate nature of even scientific truth.
14. Recognize the applicability of scientific methods to many non-science problems.
15. Recognize the universality of cause-effect relations within the framework of probability (uncertainty principle).
16. Recognize the limitations of scientific methods particularly when applied to areas where control is difficult and where contingencies and unponderables are numerous.

b. In setting objectives of any kind, teacher must know
1. Where pupils are at any grade level.
2. Where she wishes to go with them.
3. What obstacles exist in the way.

3. Breaking the traditional circle.
a. Critical thinking can be handled at any level.
b. Present teachers have not been trained with this as a basic objective.
c. A necessity exists for giving more than lip service to critical thinking as an objective in science courses at all levels.

4. Preparing teachers for handling objectives of critical thinking.
a. *Through regular science courses.*
1. *Appropriate examples should be set at all levels of teaching.* Various members of the group offered the following examples from their own practices in college classes or with student teachers.
(a) Use of demonstrations, laboratory work and individual projects for inductive problem solving.
(b) Use of demonstration and laboratory materials as *evidence* in a larger picture of problem solving rather than in cook book routine.
(c) Planning of courses around key investigative questions organized into question outlines covering lectures, discussions, reading materials, demonstrations, projects, laboratory work, reading. Such questions centered around basic concepts and big ideas of science.
(d) As much as possible, use of texts and references before first hand experiences rather than the reverse.
(e) Use of occasional materials in the history of science for interest contrast, simplicity or perspective in problem solving.
(f) Testing alternative hypotheses of different students. That is, testing unsuccessful as well as successful hypotheses.
(g) The lining up, in advance by the instructor, of the principles and objectives to which investigations would lead.
(h) Following through with new problems that emerge from old.
(i) Stage-setting for problem solv-

ing. E.g. discussion or argument is started in order to introduce materials on hand as evidence to settle the argument or discussion.

2. Difficulties to be faced in teaching for critical thinking.
   (a) Large classes.
   (b) Limited time. Emphasis upon basic concepts and big questions could help here.
   (c) Lack of background of teachers for handling critical thinking.
   (d) Not all questions or problems can be directly investigated.
   (e) The vicious circle mentioned above: Because most teachers themselves do not have background for critical thinking, they do not provide such experience to their own students.

b. Through special science courses in critical thinking e.g. Courses in the history and in the philosophy of science in some colleges and universities can provide some background and sophistication for critical thinking.

5. The following members of the group have available individually prepared mimeographed or printed materials on scientific thinking that they will send upon request:
Dr. Arnold Lahti, Science Dept., West Washington College of Education, Bellingham, Washington
Dr. Brenda Lansdown, Brooklyn College, Brooklyn 10, New York
Dr. James Perlman, San Francisco State College, San Francisco 27, California
Dr. F. A. Riedel, 1129 Glenwood Blvd., Schenectady 8, New York

IMPLICATIONS FOR ELEMENTARY SCIENCE *

KATHERINE E. HILL
School of Education, New York University, New York, New York

When an elementary-school classroom teacher examines his work in science, he uses certain criteria, consciously or unconsciously, in appraising the effectiveness of his teaching. Perhaps one potential set of criteria might be used to furnish a teacher guidance in determining the impact of the present science program upon his children, while another set of criteria might be used to furnish guidance in increasing the excellence of his own work.

The questions which follow are suggested as possible orienting points in developing the first set of criteria.

1. Is enthusiasm for science experiences apparent among the children? Enthusiasm is manifested in various ways. Curiosity about natural phenomena probably will be present. Children will be willing to work to discover possible answers to their questions. They will be eager to share information, investigate ideas, suggest hypotheses, and test those hypotheses.

2. Are the children using a variety of sources of information? Of course, they will use printed materials, such as books, magazines, and newspapers. But they also will seek information from informed persons. They will observe phenomena and manipulate materials in order to acquire information. In all instances, the teacher will act as a guide in aiding children to assess the reliability of the source of the information.

3. Are the children attempting to clarify concepts? A perceptive teacher listens to children's questions. He is aware that one measure of growth is related to the kinds of questions each child asks. Such a teacher is alert to the frequency of questioning, to

* Paper presented at the meeting of the Council for Elementary Science International, Sheraton-Gibson Hotel, Cincinnati, Ohio, February 28, 1959.

the changing vocabulary used in the questions, and even more, to the kinds of questions asked. In the latter instance, the questions of individuals will give more and more evidence each year that questioning is for the purpose of clarification of concepts rather than being casual requests for identification of phenomena or superficial queries concerning observed reactions.

4. Is there evidence of a variety of levels of thinking among the children? If the answer is negative, the child's goals may be retention of specific subject matter rather than the use of subject matter to clarify concepts. A stimulating science program will challenge all the children in a group, but it will challenge each child in a different way and to a different degree. Thus, a variety of levels of thinking in relation to a particular topic will be apparent. However, one would not be content merely to acknowledge this variety in levels of thinking; one would hope to provide the kind of learning climate which would result in continual, individual progress in thinking.

5. Is individual progress being made in relation to the acquisition of desirable attitudes? Such valued aspects of growth in thinking as the use of suspended judgment, exercising of creativity, and checking with reliable sources should become more and more apparent as children progress.

6. Is there evidence that the science information acquired by children is modifying their behavior? Concern about erosion on the school grounds, consulting the weather forecast when an excursion is planned, or discovering the depths at which to plant different types of bulbs prior to the planting indicates a translation of information into action.

The teacher's role is fundamentally one of aiding children as they seek to interpret phenomena in the environment. He is a guide, a counsellor, a challenger. With this in mind, let us turn to questions which might be the basis of a set of criteria which a teacher might develop to explore his role in the science program.

1. Is science an important part of the curriculum? If a teacher considers science to be an essential area for learning, this viewpoint carries over to children. Sufficient time, space, and materials will be made available for worthwhile learning experiences.

2. Is the science curriculum balanced? This will be evident in the selection of content from both biological and physical sciences. It will be evident also in the use of content drawn from the scientific heritage as well as from more recent advances. Further, day-to-day, as well as longer-term planning, will tend to assure balance in content and in experiences.

3. Is there enthusiasm about science as a part of the curriculum? A teacher who is curious, who is free to admit lack of information, but who is willing to learn is apt to be enthusiastic. The spirit of such a teacher brushes off on the children he guides.

4. Is there concern about the learning process in relation to science? Helping each child to move at his own pace toward clarification of concepts is one measure of this concern. Determining levels of understanding among children and providing for individual progress in discussing, manipulating, reacting, planning, hypothesizing, summarizing, and evaluating are other facets of this concern. Further, it is necessary to be aware of individual interpretations within a group-learning situation.

5. Is there constant study of ways to improve children's learning in science? Ongoing experimentation with an evaluation of new techniques, content, and materials is essential if the science program is to be a vital part of the total curriculum.

Developing criteria for evaluating one's science program is the teacher's concern. Using these criteria is a constant process, an intrinsic component of teaching. Much progress will be made in releasing the creative potential of children if the teacher is his own most careful and most persistent critic.

MY CLASSROOM SITUATION *

ULLAINEE DOWNING
Cincinnati Public Schools, Cincinnati, Ohio

I AM one of the fortunate teachers whose job is that of teaching science. Elementary science, to be sure, but teaching science in today's classroom presents a challenge at all levels.

I am doubly blest in working with children who come from homes where parents are vitally interested in what is going on in school. Their interest is reflected in the way the children function at school.

Sometimes their exuberance is exhausting. Sometimes I wish they didn't have quite so much to talk about, but then wouldn't I miss that twinkle in their eyes as they crowd into my classroom. They are so eager to tell me the "latest" that they can't wait to get inside the door before they thrust books, magazines, clippings, pictures, homemade gadgets, rocks, snails, etc. into my hands with a "Look what I found", or "Did you see this", or "What is it?"

As you have surmised, there is a free, relaxed atmosphere in my classroom. They come willingly, eagerly, because to them SCIENCE is spelled with all capital letters.

How does it feel to work with such children? How does one keep up with them? Can you get them settled down to do a piece of work?

I find myself avidly reading periodicals to keep abreast of current happenings in science. The daily newspaper provides enough material in a week's time to outdate any science book on the shelf. I can't afford to miss reading the paper one day for fear I'll miss the best chapter in the book.

My children are reading these same materials. These they bring to me for answers, explanations, clarifications, the inevitable questions—Why? How?

The answers aren't to be found in the books on the shelves, so the books have to serve as a means to find the answers. The children have to be taught how to use the books to the best advantage. By their use we can build stepping-stones to understanding the present questions.

In my classroom I try to teach my children to think, to reason, and to make judgments for themselves. This isn't something that comes quickly and easily. It isn't an exercise or unit we work on for a few days and promptly forget. It is an underlying principle of every class period. I believe that the manner in which they arrive at a conclusion is far more important than the final fact they have learned. I don't want them merely to acquire a vocabulary of the right words, or an assortment of unrelated facts. I want them to know how to gather information and how to examine it. I want them to challenge the ideas brought forth and have valid reasons for their conclusions.

How does one go about this large order? Each of us has many ways of presenting materials. We rarely use the same procedure for teaching each of the many units we work on in a year's time, nor do we use the same procedure from year to year. We find some link to join each unit to the preceding one so that there is a continuity to the learning process.

There are many ways to stimulate children and start them thinking about a particular unit. It may be a picture or chart tastefully arranged and prominently displayed on a bulletin board, or a collection set up on a table, or one of my favorites, an experiment set up.

As my charmers sweep into the room it isn't but a few seconds before they have spotted the something different from yesterday. Then the questions, comments, and probable solutions start to roll. "What is it?" "How does it work?" "Are we going

* Paper presented at the Council for Elementary Science International meeting, Hotel Sheraton-Gibson, Cincinnati, Ohio, February 28, 1959.

to study about this next?" "Can I make it work?" "What's this wire for?" "Why? Why? Why?"

Without half trying, we are into a discussion. Before we finish I discover what kinds of information they possess about this area of work. I ascertain the weak points and note the incorrect ideas, so that I can be sure these things will be clarified as we progress. Then with the concepts of the grade level in mind I can proceed to make sure past information is correct and then use it as a building block to further the understandings being developed.

I use the science books as reference books rather than Readers. Pertinent films and visual aids strengthen or clarify points that sometimes seem so hard to explain. Sometimes the children make oral reports to bring to the class some materials they have gathered outside the classroom that is appropriate to our study. Occasionally we make notebooks so that our techniques here are not neglected. We go out on the playground, sometimes, to observe first hand a problem we are concerned with. Most enjoyable of all, of course, is working an experiment. Here again, I may perform the actual experiment, or each of them may get into the act. Whatever method is used, the children tell me before we start what they expect will happen and why. I never tell them yes, that's right, or no, that's wrong. I let them discuss, argue, if you like, what will happen and why they believe this to be true. They may be right and the experiment will prove them so, or they may be wrong and so from the experiment reach a different understanding.

I prod and probe until they come forth with a solution, because I will not tell them the answers. They are learning to draw conclusions. They are, I hope, learning a way of life. They are learning a reasoning process that will carry over into the future. A process that they can use to solve their future problems. They have learned that the things we believe true today, were not true yesterday, and may not be true tomorrow. We work together to solve our problems and search together for the answers to our favorite questions, WHY? HOW? WHAT NEXT?

SCIENCE EXPERIENCES IN A SIXTH GRADE CLASS *

Irene M. Lammers
Westwood School, Cincinnati, Ohio

The 36 young members of this class come from good average homes in a suburban community. There is a public library nearby and our classroom, itself, is rich in reading materials including many good science books and four sets of encyclopedias. Most of the science equipment is simple and inexpensive. We do have two good microscopes, four or five prisms of different sizes, seven or eight magnets of different sizes and strengths and the usual other science material found in classrooms. Our media for expression consists of clay, plaster of paris, paper mâché, chalk, paint, wire, charcoal, crayons and payons.

In previous years my classes have had science clubs in which the youngsters held many interesting meetings and found new and exciting ideas in science. The children in this year's class had heard about the science clubs and were very eager to have one of their own.

Following simple suggestions from our language books, the class organized its own science clubs, complete with a president and other officers. Since it seemed important

* Paper presented at the Council for Elementary Science International meeting, Sheraton-Gibson Hotel, Cincinnati, Ohio, February 28, 1959.

to give many children chances to hold office, we decided that our elected officers would hold office for only one month. At the end of each month, the class would elect new officers.

The children were free to follow the study of any field of science in which they had special interests. The aim was to create an interest in many fields of science and to encourage the children to read in these fields and to bring their information back to the group. It was a form of oral reporting, but it seemed to be more interesting and grown-up to report at a club meeting.

I wanted the children to discover that science is both interesting and challenging. No unit was forced upon any child. The choice was purely one of interest, and therefore the work was partly individual, partly done by group effort. If a youngster was doubtful about what he wanted to do, I suggested possibilities and he browsed around for a few days. Two or three children wanted to work in one field because friends had chosen it, but in most cases the choice was made on the basis of interest. Each student was free to work with a group or to work alone.

We met for one period every other week. Sometimes we took part of the social studies or language arts time since I felt that all three fields were involved in the work done for this club.

Some of the research and model making had to be done outside of school time. Sometimes it was done at noon on rainy days, sometimes before school, and sometimes at home. The aim of the person reporting was the sharing of something he had found out with his classmates. We saw this with Fred who got quite involved in the matter of light rays and color.

The following examples illustrate some of the activities in which the children have been interested this year:

Rocks and Minerals. Some of the girls are now constructing a paper mâché volcano; they are also trying to do some work with polishing stones.

Fish and Fishing Tackle. This proved quite interesting to some of the boys who brought in home-made flies and many lures. They told about the advantages of lures over live bait and vice versa. They told us where to find different kinds of fish: some are found in rivers and some in lakes. They investigated the pollution of the Ohio River and what happened to the fish in it; only catfish are left. A clipping from a local paper brought our attention to the walleyes which can be caught in lakes and streams around Cincinnati. The boys discussed the structure of fish and how they breathe. To illustrate their discussion, they had a skeleton of wire showing the structure of the fish. They also told us what the government is doing to improve fishing possibilities in our community.

Insects. A TV program aroused the interest of a group of girls in mounting insects. They wanted to know what the government is doing to help the farmer combat harmful insects. This led them into the study of insecticides and the ability of insects to resist them. One girl branched out into the study of insects which help man.

Tools and Instruments. One boy, whose father is a hospital technician became interested in the tools which scientists use.

Planets. The planet group made its report in the form of dialogues between earth people and people from other planets. The visitors had been invited to come to the earth for a universal conference on science.

Outer Space. One boy is attempting to make a telescope and is growing more and more interested in lenses and filters.

Birds. One group of girls became interested in the quail bill which is coming up for a hearing before the legislature. In a lively debate about why the quail should or should not be on the game bird list, they discussed the value of quail, why they are becoming scarce, and what is happening to the cover for them. They wrote to the Department of Conservation for information which they will report on later.

Camera and Eye. When some of the

boys became interested in the camera, they found that it works like the eye. Then they branched out into the study of the eyes of both humans and animals. When the boys brought a calf's eye to class, the girls as well as the boys wanted to hold it (although no one who did not want to touch the eye was forced to do so). One girl said, "It was just like holding the egg when you try to separate the yolk from the white and the white keeps slithering away from you." A boy answered, "That's the vitreous humor." Martha answered, "Oh! In an egg it's albumin."

Light and Prisms. Fred and Mike experimented with light and prisms. Mike is color blind and these two boys did considerable work with the spectrum and light rays.

Reptiles. Austin became the class authority on snakes and other reptiles and amphibians. This proved to be of considerable interest. He brought in a snake bite kit and showed us what to do in case of a snake bite.

Besides gaining new knowledge in science, the children learned more about working with other people. From this club the children have learned to accept criticism as well as to give it. They learned how to be kind in giving criticism and to give constructive and not destructive criticism. There are four rules we try to follow in giving criticism: (1) Is it necessary? Would the report be improved because of it? (2) Is it given in a kind way and is it kind to give it? (3) Would I like it given about me and my report? (4) Is it important or am I being "picky"?

At first it was hard for some of the more timid ones to report. Kerry was literally scared to death, but she stuck it out and said afterwards, "They were so nice and they looked just like always. I didn't mind after a while."

There is a growing ability to pinpoint a question and to ask for and to give specific information. There are still many erroneous statements but after a club meeting we discuss accuracy and authenticity.

New words are not only being read, but are being used in the reporting and in the discussion which follows. One good example of this was Jack's remark after Kerry's talk. "Kerry thought she was in a predicament, but she got out of it." We have a "word of the week" which we try to use in our conversations or in reports; predicament happened to be the one for that week.

Not only have we gained a greater interest in science but self-evaluation and appreciation of the efforts of others is growing. There is a sympathetic and helpful attitude toward the timid child. Cooperation is paramount. Respect and attention to details and accuracy are noted. There is a greater interest in science through newspaper clippings and magazine articles which are constantly being brought in and discussed.

No specific date is set for each group's report; it is purely voluntary, but each one wants to talk. At each meeting someone asks to report at the next meeting. No pressure is felt for meeting dead-lines.

No one hesitates to say "I don't know." When any questions cannot be answered by the reporter or by a class member, they are referred to the next meeting. The reporter feels his responsibility for trying to find the answer to his particular question. There is more research, more reading and more wanting to read—and more interest in science.

TELEVISION IN THE SCIENCE CLASSROOM *

John H. Grate
Cincinnati Public Schools, Cincinnati, Ohio

As we live and teach in the age of science and as the numbers we teach increase, it seems quite fitting that science itself should develop an instrument which can do a more effective job of science instruction. Of all the subjects treated by educational television, science has proved to be the best adapted to the medium and the most rewarding.

Teachers, and those concerned with developing an acute awareness and broad understanding of scientific phenomena, must not overlook the advantages that television offers. As we attempt to utilize television, science teachers should keep an open mind and a spirit of experimentation, those same qualities we seek to develop in our pupils.

In-school use of television has been viewed from several angles. Some look at it as a solution to the teacher shortage; others view television as an opportunity for upgrading teacher skills, for providing continuous curriculum revision and for better integrating the child's learning experiences. We know that the role of the classroom teacher in a dynamic learning experience like science is one of great importance. With this knowledge wherein lies the role of television in the science classroom?

Presently, the Cincinnati Public Schools are engaged in an experiment designed to determine this role. Is it possible for the television instructor and the classroom teacher to combine their abilities into a team approach which might be more effective than the conventional method of teaching? Is it possible through the use of television to bring into the classroom educational experiences which the student might otherwise not have? Fifteen schools, with matched experimental and control groups in each, make up the units in the experiment. Thirty-three other Cincinnati Public Schools have at least one sixth-grade viewing the telecasts. Beyond this, there are a number of schools in the county and Kentucky, as well as parochial and private schools, viewing the science lessons.

Units and subjects covered are typical of elementary science. *Living Things* concerned itself with the needs and adaptation of plants and animals as well as reproduction and conservation. *Beyond the Earth* added to the study of astronomy, the timely subject of space travel. Atomic and solar energy were added to the more conventional offerings on *Energy*. *Atmosphere and Weather* discussed meteorology from the standpoint of prediction and man's efforts to modify the weather. *Our Changing Earth* will use the continuum of the geological timetable to weave its thread of understanding. Care to apply and integrate the offerings with the everyday life of the child is held all-important.

Wherein lies the success of television instruction? The television people speak of their viewers as being a captive audience. There does seem to be some magic to the television screen—what the magic is, we do not know. What we do know is that television instruction must employ all of the principles of good teaching plus known techniques of good telecasting. There is nothing inherently educational in television. It is an electronic instrument of communication and that is all. The success that it may achieve is based solely on those preparing and televising the lesson as well as the teacher in the classroom applying all of her insight to the learning experience.

The television medium is intimate—it speaks to the individual child and can evoke silent and vocal responses. It can eliminate many distracting influences and focus the child's attention on only those things that are to be stressed. Each child is given a

* Paper presented at the Council for Elementary Science International meeting, Sheraton-Gibson Hotel, Cincinnati, Ohio, February 28, 1959.

front row seat. Good close up views of many things are made available to large numbers in a short amount of time.

Time, the tyrant of the classroom teacher, is on the side of the television teacher and because of this, many benefits are reaped by the child.

A more integrated unit and lesson organization can be developed. Increased effort can be placed on the selection of subject matter, developing vocabulary and varying techniques of presentation. Careful selection of activities which develop scientific attitudes as well as promote the mastery of scientific concepts and information is possible. Time is available for the selection and preparation of visual materials, for obtaining and using expensive equipment, for surveying community resources and planning effective ways of using them, and for arranging the appearance of experts whose material can be planned to relate to the interests and capacities of the children.

The use of the rear screen, rayoscope, film clips, slides, charts, etc., can be so interwoven as to provide the best instruction possible in the time that is available. Television can bring into the classroom far richer educational experiences than have been possible before.

It remains that children learn from doing. This means that classroom activity and experimentation are necessary for a meaningful experience. Therefore, the role of the classroom teacher cannot be minimized in the proper use of television instruction. The successful use of television demands the cooperation of the classroom teacher. A negative attitude on the part of the classroom teacher can be an even greater block to learning than such an attitude on the part of a child. The classroom teacher must personalize the learning situation, clarify and expand the offerings of the televised lesson. It is up to the classroom teacher to adapt the lessons to the needs of her class and to hold them responsible only for the material commensurate with their ability. The teacher's job is not made any easier by the televised science lesson.

In talking with children and teachers the following reactions to the television lessons have been stated:

> Television instruction is more interesting. They like having more than one teacher. They learn more with television, but they have to work much harder. Television requires more attention.
>
> Teachers appreciate the telecasts. They have to work much harder. Children are stimulated to delve more deeply into subjects. Greater use is made of reading materials. Tardiness and absence have fallen off.

Educational television is still young and is suffering those pains that go along with maturation. It is no longer a question of TV or no TV, but one of careful definition of the role of the television in the classroom, allowing enough time for the integration of the telecasts and classroom experiences into a meaningful whole.

One great value of television instruction lies in its ability to capitalize on many opportunities for good teaching which the classroom teacher is unable to use because of lack of time and facilities.

Television is nothing more than another audio visual aid (a good one to be sure) that can enrich and elevate our science programs if we do not expect more than the instrument itself can give. We can reap the most from it if we get it out of the auditorium into our classroom and accept the responsibility that goes along with having it there.

THE ROLE OF THE COLLEGES IN CURRICULUM † IMPROVEMENT IN ELEMENTARY SCIENCE *

JOE ZAFFORONI
University of Nebraska, Lincoln, Nebraska

WHAT MAN KNOWS

Man's Limitations?

"THE millenium is at hand. Man has invented everything that can be invented. He has done all he can do."

These words were spoken by a bishop at a church gathering in 1870. They were challenged by the presiding officer, who suggested that a great invention would be made within the next fifty years. The bishop asked him to name such an invention.

The reply: "I think man will learn to fly."

The bishop replied that this was blasphemy. "Don't you know that flight is reserved for angels?"

The bishop was Milton Wright, father of Orville and Wilbur.

Likewise there is no limit as to what the future holds for the improvement of instruction in elementary science. Improvement of the curriculum may come through doing better what schools are now attempting to do, or through attempting to do new things that are in some sense, better things to attempt.

No single research technique will solve all curriculum problems. Leadership for curriculum planning may come from a variety of sources.

You have just heard a most provocative report of how a state studied its curriculum presented by Dr. Ready. Within every state numerous resources are available for utilization in curriculum improvement. The contributions of the philosopher, the psychologist, the social scientist and the scientist are all essential in the development of basic insights about the nature of the individual and the society in which he lives. However, it seems that curriculum improvement will come about primarily as there are actual changes in the day-by-day classroom experiences of boys and girls.

The emphasis during the last ten years on action research suggests that this is more likely to happen when teachers themselves work cooperatively with consultants from many fields in the solution of educational problems.

This kind of research calls for the cooperative actions of many persons who will continually probe into and develop new techniques of working with children.

The colleges can and often do provide opportunities for this kind of research to come into being.

One group of teachers under the supervision of a college instructor identified specific, practical problems related to their immediate situation and proceeded to resolve them according to their needs.

One teacher chose to compile a list of reading materials for enrichment of her science program.

Another chose to study factors involved in improving her techniques in problem-solving.

A group of teachers chose to make a study of what children think scientists are really like.

Another chose to study the effect of room environment on developing interests in science.

Another chose to study the effect of use of simple materials in the teaching of science.

One teacher chose to study the facilities and materials of her building for science instruction.

† From an address of the Reverend Walton Cole at the Twenty-sixth Biennial Council, Phi Delta Kappa.

* Paper presented at the meeting of the Council for Elementary Science International, Hotel Jefferson, St. Louis, Missouri, April 3, 1959.

These and many other problems were close and significant to the classroom teacher. This kind of research was kept simple and closely related to children. This kind of involvement seemed to make a difference in the quality of science instruction that occurred in the classroom. Teachers reported the results of their study enthusiastically to other group members.

Change took place as the result of this kind of study by the teacher himself. Each study led to action. Consultation with college personnel contributed toward helping the teachers evolve and sharpen their plans for study of these problems.

WORKSHOPS CONTRIBUTE TO IMPROVEMENT

Science workshops can be used to good advantage in improving instruction in elementary science. Colleges frequently provide personnel for workshops in elementary science. These workshops are often a part of the in-service teacher education of a particular school system. Workshops may involve teachers for a two-week period as followed by many school systems, such as Battle Creek, Michigan. This workshop is unique in the following respect:

Teachers move to Clear Lake Camp. Here they live for two weeks as a group. Facilities are provided for the entire family if the member wishes to have his family with him. Workshop schedule calls for a day beginning at nine and ending at three. Recreation is provided for the entire family. Camp counselors are available. College personnel serve as consultants to the workshop. This workshop is planned and coordinated by the administration and teaching personnel of the public school system. Curriculum problems are identified and studied during these two weeks.

In Nebraska, Florida, and Kansas, I am personally acquainted with workshops in science that are held for two and three day periods usually before the opening of the school term. Emphasis is well placed on the fact that in all respects the workshop experience must be a satisfying one for the teachers. The following characteristics are cited as common to all science workshop experiences which seemed profitable for the members of the group.

1. The workshop deals with problems of concern to the classroom teacher.
2. Workshops involve working with subject matter as well as methods of instruction. It is a "doing" experience.
3. The subject matter is kept challenging and should be encouraging to the learner.
4. The workshop is designed to accomplish specific objectives.
5. Intelligent pre-planning by all personnel in the role of leaders.
6. Strong emphasis placed on experimenting, observing, on taking field trips is urged. These experiences are provided in such a way that the teachers own methods are improved.
7. Definite follow-up after the workshop is completed to insure improvement of instruction.

VIEWS OF WORKSHOP PARTICIPANTS

A teacher said this:

"This has been one of the most valuable teaching experiences that I've ever had. Seeing things actually done before our eyes was so helpful and removed so many doubts that are often left when there is only talking and reading. Actually doing helped me feel that I could do things in science. The science idea of the teacher being the learner was such a relief and change. It gave me a more relaxed feeling."

Workshops carefully planned stimulate and inspire teachers to improve instruction.

"I feel that this has been a wonderful two days. I'm going home with some ideas that never occurred to me before. I feel good about science."

"I enjoyed the 'doing it myself' period as much as my children will. I believe I learned more during the time I did something than being told."

"To tell you the truth, I really have cleared up many things which I have always had trouble with. Many of my science problems such as the experiment I participated in (magnetism for example) have made a clearer picture in my mind."

A principal said this:

"I have heard my teachers says, 'I have taught every topic I can think of. What shall I teach the rest of the year?' Now we'll have something to talk about in our staff meetings."

These and many other testimonials give evidence of the feelings that classroom teachers express concerning workshops as a technique for the improvement of science in the elementary school.

When workshops are conducted by institutions of higher learning, the problem of granting graduate credit to those who need it is a problem which deserves careful study if such institutions are to meet the needs of elementary teachers.

Another role taken by a college in curriculum development may be seen in the following description of the Nebraska Community Education Project which has been in existence since 1956. This project is officially known as the Nebraska Community Education Project Curriculum Experiment. A city superintendent acts as the director. The central project staff at the University of Nebraska is helping to initiate and coordinate the work.

An assumption underlying the experiment holds that students will adopt better behavior patterns in terms of relations with others and community life in general if their learning is more closely related to community process. Another assumption, and maybe even more important, is that community and experience-centered learning will, while producing better behavior patterns, also allow the student to learn at least as much in terms of fundamental skills as they would under more traditional teaching procedures.

The guides to selection of experimental activities are simple and they are not new. However, it is the contention of those engaged in the experiment that they are too often overlooked. These guides are:

1. Does the activity constitute wise educational use of community resources?
2. Does the activity include experience-centered learning activities?
3. Does the activity lead to helping the students solve problems now or to community improvements?

Some study and a little experimentation was conducted in the spring 1958 semester. An extension and expansion of the work was planned for the 1958–59 school year. The actual curriculum work was preceded and interspersed with planning sessions. In fact, one of the most important 1958 summer session meetings on the University campus is a Curriculum Experiment Workshop. The primary functions of this summer workshop are to review and evaluate what has been done and to plan for next year's activities. This planning for acivities in the Curiculum Experiment is cooperative. Having voice in the decision are representatives of the local teachers and administrators, University faculty, and the State Department of Education. Every effort is made to make the experimentation sound, virile, and acceptable to all educators concerned.

Science in the elementary schools and social studies at the secondary level were the initial work areas. During the current school year, 1958–59, science and social science is being studied at both elementary and secondary level.

This is another illustration, though briefly described, where the role of the college is being felt in curriculum improvement.

Another illustration which implies the role of the college in curriculum improvement is cited in a project which has been in existence over a period of four years. This project is known in Nebraska as the Westside Community Cooperative Project developed upon a cooperative basis by the Westside Community School System and Teachers College, University of Nebraska. An excerpt from a report indicates:

> "A very stimulating opportunity for Teachers College staff members to work with teachers on the job in the planning of curriculum experiences that represented new and experimental approaches to a particular situation. Staff members have repeatedly stated in most enthusiastic terms their appreciation for the opportunity to work with the Westside schools and the contributions it has made to their professional growth."

And so—these and many other ventures with curriculum improvement are presently being undertaken by school systems throughout the United States. The role of the colleges is being felt in every state. Off-campus courses, workshops, supervision and guidance of research, pre-service courses and the use of television are just a few of the situations in which colleges are

making contributions to the improvement and instruction in elementary science.

In places where the most successful pre-service work is done there is a close relationship between the liberal arts college and the school of education. There must be mutual respect and understanding between science teachers and other educators to insure the best results in the program.

As students associatte what they know about the nature of children with appropriate science content in professional courses then the improvement of science is inevitable. As college instructors teach as they would wish their students to teach, the science curriculum will improve. The college can make this experience possible for today's student who becomes tomorrow's teacher. As colleges themselves approach curriculum improvement with awareness, creativeness, flexibility and boldness then—what college knows—College's Limitations?

PROPER EMPHASIS ON SCIENCE AND MATHEMATICS IN THE ELEMENTARY SCHOOL *

W. RICHARD HARGROVE
University of Oklahoma, Norman, Oklahoma

SCIENTISTS, teachers, and school administrators (and there is notable overlapping among these groups) have addressed themselves to the question of what and how much science and mathematics should be provided in the elementary school. As answers to this question are garnered, a further question arises as to what changes are needed and practical in curriculum organization. Our purpose is to suggest some ideas to those who seek answers to these prickly questions.

A review of the current professional literature reveals considerable agreement as to the purposes of teaching science and mathematics in the elementary school. These purposes provide a needed frame of reference for speculative answers to the questions posed. Summarized, the primary purposes would appear to be the following:

1. To help every child understand better the quantitative and phenomenal aspects of his environment.
2. To help the pupil develop concepts and skills in a sequence which will allow him to pursue higher studies in specialized fields.
3. To place social tools in the hands of all our citizens.
4. To encourage the most rigorous thinking of which a pupil is capable.

While it belabors the obvious to point again in this paper to our ever-increasing rate of technological change, it is important to throw into bold relief the forces in our society which must necessarily impinge upon curricula. But while continually making adaptations in the face of immediate needs, those who shape our schools must not lose sight of ultimate human aspirations and longings. In pragmatic terms, the question becomes not how much science and mathematics are desirable, but how much can we have in deference to other needs. Such a state of affairs makes necessary a system of priorities where curricula are concerned — priorities which are predicated upon our needs to survive, to progress materially, and, in the words of Mr. Adlai Stevenson, to help the human spirit triumph. Thus in modifying curriculum patterns, new emphases must be delicately balanced.

With the foregoing in mind, the primary emphasis in the early grades cannot properly be on science and mathematics. Instead, the emphasis should be on the acquisition of the tools and skills of communication. The paramount purpose of

* Paper prepared for meeting of the Council for Elementary Science International, Hotel Jefferson, St. Louis, Missouri, April 3, 1959.

education in the primary grades would rightfully appear to be to help the child develop the proficiencies which will enable him to begin to be independent in gathering and evaluating information.

It has been noted well, however, that children are able to develop many numerical and scientific insights. Arithmetic has social utility, of course, and children have need to understand their natural environment. It would be arbitrary indeed to wait until some specified time to begin the whetting of children's intellectual appetites for science and mathematics. So while inquisitiveness and rational thinking must generally be cultivated during the early grades, certain elementary concepts should be selected for systematic development.

For the upper elementary grades, the teaching of science and mathematics should be more intensive and specific than in the primary grades. Intensiveness and specificity, along with balance, can better come about, it is believed, as the result of a strong disciplinary approach. This view is based on the conclusion that we have few real disciplines in our public schools—and a similar statement could be made relative to collegiate curricula. One has but to glance through a university catalog to discover new courses and departments of instruction which presumably constitute new disciplines as man pushes back the frontiers of knowledge. Few of the traditional disciplines are sacrosanct today.

It is suggested that a discipline for the elementary school be defined in terms of achievable objectives or suitable concepts for a given group of boys and girls. Science in the grades must not be allowed to become a smattering of facts or a watered-down version of college science courses. The confusion among professional educators regarding the terms "correlation," "integration," "fused curriculum," and "core curriculum" is well known. It is the opinion of this writer that this confusion is very possibly the result of an unconscious search for disciplines appropriate for the elementary and secondary school years.

In some states—Georgia, Florida, and Oklahoma are among them—efforts have been made to use concepts as the basis for organizing curriculum guides pertaining to science and mathematics. It follows that concepts selected for a particular age level can comprise a real and usable discipline around which the learning experiences of the elementary school can be designed.

State departments of education, through their curriculum committees, might well serve as the centralizing agencies for suggesting at least the broad outlines of various curricula. Any planning group would do well, of course, to be abreast of efforts being made at the national level by professional organizations to suggest the scope and sequence of instructional programs in science and mathematics. As our needs grow ever more national and international, geographical distinctions among curricula are likely to become less apparent. State planning groups and national organizations will doubtless cooperate more and feel freer to borrow ideas as we become less provincial in our curriculum planning.

Wherever these objectives and concepts make up appropriate disciplines for our elementary schools, the creative teacher can choose to employ the subject approach and integrative learning activities. Using one learning activity or project to meet objectives from two or more disciplines has the advantages of saving time and efforts and of increasing understanding when children see the interrelationships of the disciplines. The single subject approach is particularly helpful where the sequence of concepts is of great importance. The most skilful teachers are not wholly committed to either of these approaches but use both for different purposes.

The agreement upon concepts to comprise elementary school disciplines should do much to remove those interested in science and mathematics teaching from the

subject matter vs. methods impasse. A concept for the first grade might be "Soil will dissolve in water." Clearly implied here is a generalization of a factual nature to be reached by the child. But also compelling is the need for a demonstration of soil being dissolved in water if there is to be maximal understanding and learning. The fundamental consideration is that the teacher be aware of his responsibilities to the objectives and concepts regardless of the particular approaches to them.

THE NORTH CAROLINA CURRICULUM STUDY *

I. E. READY

Director of the Curriculum Study, North Carolina State Board of Education, Raleigh, North Carolina

On April 1, 1958, the North Carolina State Board of Education initiated a study of the curriculum of the public schools of the State. The fact that the study began on April Fools Day had no significance: it is in no sense undertaken with a "tongue in cheek" attitude. The study was to be a serious attempt to improve the curriculum of the public schools. Its genesis was the shared conviction of many people that the public school is vital to America's future and that the need for improvement in public education is urgent.

The shared conviction of the need for a study is based on many things. One consideration is the belief that the challenge to America's future—posed by scientific advances, the world-wide Communist threat, and the United States' leadership of the free world—makes it essential that educational opportunities not only be available but that they be of high quality. Another consideration is that we are in need of creative people in all areas of our culture. If we succeed in our job of protecting our physical freedom in the world, we shall have left the more difficult job of leading and moving in a world of ideas—of maintaining our economy through the quest for new knowledge—of contributing a leading share of the advancement of man's culture.

Early in the plans for the State-wide Curriculum Study it was agreed that this would not be just a status study. It would attempt to identify strengths and weaknesses in the curriculum in order to bring about improvement. The plan of organization and the method of conducting the Study would have to be developed in such a way that desired improvements would be secured. For this reason, it could not be a copy of another study; nor could its various steps be completely planned in advance.

DIRECTION AND CONTROL OF THE STUDY

The Curriculum Study is under the direction and control of the North Carolina State Board of Education. The Study was authorized by a resolution of this Board. Recommendations that may grow out of the findings of the Study will be reported to and released, as approved, by the State Board of Education.

Immediate responsibility for the Study has been delegated by the Board to the Policy Committee of this Board. Policies that give direction to the Study are developed by this Committee and approved by the Board.

The director of the Curriculum Study is employed by the Board and is responsible to the Board through its Policy Committee for the development and conduct of the Study. He is delegated necessary authority within the budget and consistent with the policies adopted by the Board for the Study.

The development of the first stage of the

* Paper presented at the meeting of the Council For Elementary Science International, Hotel Jefferson, St. Louis, Missouri, April 3, 1959.

Curriculum Study was made possible by a grant from the Richardson Foundation.

SCOPE OF THE STUDY

The Study is at present limited to the curriculum of the public schools in North Carolina, grades 1–12. The curriculum is defined as all organized educational experiences of students under school auspices.

PURPOSE OF THE STUDY

The purpose of the Study is to bring about improvement in the curriculum by encouraging wide-spread lay-professional study of the curriculum of local schools and by a careful evaluative study and recommendations for improvement on the state level.

BASIS FOR EVALUATING THE CURRICULUM

In very broad terms, the curriculum will be evaluated in terms of "the right of every child to burgeon out all that there is within him." [1] This concept of total education envisions both quantity and quality. The optimum condition would require that appropriate educational opportunities of excellent quality be available and that students take full advantage of the opportunities offered. It follows that parents, board members, administrators, and teachers must be effective in their roles.

The following basic questions will be asked:

1. What are the purposes of the public school?
2. How well is the curriculum achieving these purposes?
3. What improvements are needed?
4. How can the needed improvements be realized?

METHOD OF THE STUDY

The State-wide Curriculum Study is both a movement and a study. As the attempt is made to stimulate and aid curriculum study on the local level, it is a movement for curriculum reform. As the attempt is made to identify strengths and weaknesses in the curriculum and to recommend improvements state-wide, it is a study.

A significant feature of the North Carolina Curriculum Study is its "grass roots" approach. It is assumed that the real improvement that takes place is going to result from local lay-professional study and sharing of decisions about needed improvements. The State Board is asking local people this question, "What should the State do to help the teacher do a better job in the classroom with your children?" The mandate will thus come from the people to the State and not the other way around. Resulting changes in laws and regulations will be planned to help promote effective local programs of education rather than to exercise State control and force undesirable uniformity.

The staff of the State Curriculum Study does not have the resources to conduct basic research in the different subject fields. Its role in research is to bring to North Carolina schools the results of research done by such agencies as the National Science Foundation and to adapt and apply sound recommendations to local school needs.

A LOOK AT TRENDS IN CURRICULUM CHANGE

After one year, it may be profitable to look at trends that are beginning to show up in the many local studies and in the investigations of the staff of the Curriculum Study. These trends are not the only ones and they may not be in the right direction.

How Urgent Is the Need for More Effective Teaching and Learning?

There is evidence that the excitement that first followed recognition of Russia's scientific advances has given way to a soberer but no less serious point of view of the role of public education in national defense and in improving the lot of man, generally. The need for improvement in science, in the social sciences, and in the humanities is being recognized as urgent. In this connection,

[1] Quotation from speech of Governor Charles B. Aycock, the "educational governor", of North Carolina.

there is also need for more serious study from students, for more thorough instruction from teachers, and for more effective cooperation from parents.

Will Study of Curriculum Needs by Joint Lay-professional Groups Help in Securing Improvement?

The encouragement of lay-professional group curriculum study is a major point of emphasis in this Study. From other sources, also, the importance of joint lay-professional study is being stressed. In recent issues of magazines of national circulation can be found articles supporting such study.

At the same time, it is recognized that the problems of public education are too pressing to wait for a slowly developing public opinion to mold the curriculum. Small, interested groups may play an important role in directing curriculum changes and in winning wider public support for these changes.

What Is the Role of the Public School?

It may be that the weaknesses that may exist in the public school program are often due to failure of the public and the profession to agree on the proper role of the public school. A great deal of attention is being given to discussion of this role. There is some evidence that the school has been required to take on more responsibilities than its financial support has justified. Group lay-professional study is especially appropriate here. Once the role of the school is clarified and priorities agreed upon, curriculum improvement will be much easier to accomplish.

What Reforms in School Organization Are Needed?

The definition in law and regulations of the elementary school as embracing a part or all of the first eight years of school may need examination. For example, it may not be best to use the same formula for allotting teachers in grades one through eight. A better curriculum might result from a reorganization of the school program into a series of three-year units or into some other arrangement of grades.

The organizational pattern of the traditional four-year high school is being studied. Any reorganization of the elementary school pattern may influence the high school. Junior high schools and the best plan of organization for the early adolescent years are subjects for study and experimentation. The need to extend secondary education beyond the twelfth grade is also coming in for attention.

The organization of the school day is being studied. There seems to be a trend toward larger blocks of time and some combination of subject areas, especially in the junior high school. On the other hand, there is some thought given to offering more subject areas and especially to requiring more subjects of all students. If this is developed, it may lead to shorter periods or fewer class periods per week for some subjects.

The length of the school year is also being studied, both for elementary and for high school students. Especially, the possibility of using the summer months for enrichment study is being explored. Driver training, music, art, conversational modern foreign language, personal typing, and other courses are being taught in summer school in some places.

The difficulty of providing appropriate high school educational opportunities in small high schools is bringing about consolidation studies. This same consideration plus economy of operation and convenience of attendance areas are causing some school districts to consider merging into larger administrative units.

What Kind of Education Do All People Need?

The elementary school grades are generally thought of as covering a period during which each child is taught those basic subjects like reading, arithmetic, and writing

that are necessary tools for further study. Where literature, art, music, history, geography, government, and natural science are added, we have the fields of knowledge that have come to be known as general education.

That there is such a general body of knowledge and skills that all citizens need to have is usually accepted. Just what this body of knowledge and these skills are is not always agreed upon or understood; nor is there agreement on the extent of mastery of these fields needed by all students as part of general education. In fact, changing times result in changing needs. Certainly, emphases change. At present, emphasis is being given to the need for mastery by every student to the degree possible of the basic disciplines of English language, mathematics, natural science, and social science.

If, in the period of general education, all children are to attend school and a common body of knowledge and skills is to be taught, the question of standards of achievement has to be settled. What is the necessary minimum level of mastery in general education? Shall the level expected be based on the individual's ability or on some level of achievement deemed necessary for the common welfare?

Individual differences need to be recognized even in general education. It is certainly not reasonable to think that the elementary school can or should be expected to turn out children of a dead level of mastery of the body of knowledge and the skills that all citizens need. Differences in ability and effort will necessarily result in differences in level of mastery. In fact, the importance of educating not only each child but also the importance of developing his potential make it important that diversity of content and of method be provided even in the general education program of the school. We cannot afford to wait until after the general education period to identify abilities and to provide for their fullest development.

Even the time limits of general education are open to question. The eight year elementary school is not now the end either of the compulsory attendance period or of the general education program. General education has already been extended into the high school years. There is some trend toward extending it even further. It would seem that school organization and compulsory attendance laws might better be adapted to fit the period of general education. In fact, the practice of measuring the general education needs of all students by the yardstick of a certain number of years' study is in itself an unrealistic approach to the problem of individual differences.

While there is a trend toward deferring the study of elective subjects for most students, this seems to be reversed for academically able students. Even during the period of general education they may begin the study of such subjects as foreign language. Where this is done, these subjects become part of a broader foundation of academic education for these students. They may then be able to study subjects in high school that will give them advanced standing when they go to college.

How Can Sound Scholarship in the Basic Subjects Be Promoted?

The increased emphasis on English, foreign language, mathematics, natural science, and social science carries with it an increased emphasis on serious study and sound scholarship. Attention is being given to the development of good study habits.

Teachers are not being encouraged to disregard child welfare as they are urged to put more stress on sound scholarship. On the other hand, more attention is being given to the need for more thorough information about each child's ability and his needs. The importance of careful guidance is being considered. At the same time, the need to provide the study opportunities and to encourage the will to learn that will see to it that each child does develop his potentialities is considered urgent.

There may be some danger that art, music, and physical fitness may be neglected as we put more attention on other areas of the curriculum. This danger should be guarded against. All of these areas must be recognized if all that is in each child is to be developed. At the same time, it must be remembered that art, music, and sports activities have sometimes been carried beyond the "learning" stage into the "keep them busy and interested" stage. Proper proportion of time and energy must be maintained.

In connection with the emphasis being placed on more serious study, more controls on the elective subjects that students take are being recommended. This is especially true of academically able students. More careful guidance and the requirement of more academic subjects for college preparation are solutions offered. For example, thorough training in English, foreign language, social sciences, mathematics, and natural sciences is considered important in preparation for success in college.

Is the Early Identification and Proper Development of Talent Important?

The early identification and proper development of talent is recognized as an area of neglect in the past. The correction of this error is considered of great importance. Part of the reason for concern about the talented student is the belief that our country's future depends to a large extent on the quality of leadership we are able to offer in all fields. Part of it is the result of a belief that we have been neglecting our able students and that the ideal of equality of opportunity gives all students the right to a better chance to develop their potentialities. A point to be noticed is that all talents are being considered valuable, not just intellectual talents.

What Changes Are Needed in Vocational Education Programs?

In general, specific vocational skills development is being postponed at least until the last two years of high school and often into the post-high school years. A broad base of training in high school is stressed. The reasons for this are the increased mechanization and the rapid rate of change of industry and agriculture that require a more thorough general education foundation and a greater adaptability to change in ways of making a living. The combination of work and study for older students in distributive education and the further development of adult education vocational training through extension courses are other areas being studied.

The need in the economic life of the nation for professionally trained people, for technicians, and for skilled craftsmen is increasing. In business and in agriculture more and better education is being required. This brings about a high degree of competition for students who have the ability and the will to learn. The college preparatory and the vocational departments in the school want only able and willing students.

In North Carolina, area vocational schools are beginning to be organized under control of local boards of education and with state-local financial support. These schools are for specialized training of technicians on a post-high school but below engineering level and for training of skilled craftsmen. They are located in centers of population large enough to provide day students, since they do not have residence halls. Where high school students attend, they are from commuting distances in most cases.

Vocational education has in the past been largely for boys except in business education. A trend is for more girls to enter the skilled trades, especially as technicians.

While skilled craftsmen and technicians are needed, there is a reduced demand for employees of a low level of ability and training. Certainly, one lesson from this is the great importance of training each student to the limit of his ability, no matter how low this ability might be.

Are Individual Differences Being Recognized?

Individuals differ in their ability to adjust quickly and effectively to learning experiences. These differences may be due to differences in ability or training or rates of growth. Whatever the causes, they must be taken into account in planning the content and the method of the curriculum. In this connection, there are certain check points that are being recognized as needing special study. These points are the beginning years of school in the primary period and the early adolescent years in the late elementary or the junior high school period.

It is probable that children will continue to be taught in groups in the public school. This is an economic matter and is not because of choice. Research has not yet, however, given any final answer about what class size is best. Experiments are being conducted with large classes and teachers' aids. Television is also being used with this type experiment. On the other hand, many teachers testify from their experience that better teaching can be done with reasonably small classes, at least in the basic academic subjects. This seems to be especially true in the primary grades.

In an attempt better to provide for individual differences in group instruction, experiments in ability grouping are continuing where the size of the school will permit. It is important in such experiments that the right students be placed in the right sections. It is just as important that the methods and contents of the courses be planned for the children who are in the section. For example, to give as homework just twice as many of the same kinds of arithmetic examples to the advanced section so that they will be kept busy is not the right approach. These children must be challenged to do their best. They probably need less drill than the less able students instead of more.

The role of educational guidance in getting each student into the program of training that is right for him is getting more attention. This planning of the educational program on an individual basis is seen as the answer to waste of talent.

The role of standard tests in guidance and in measuring achievement is being studied. Authorities in this field urge caution. Tests can be valuable but their limitations should be understood.

What Is the Proper Place of Out-of-Class Student Activities?

The trend seems to be toward the need for reducing emphasis on certain student activities. This feeling stems from the opinion that student and public interest in activities such as competitive athletics has been allowed to handicap the promotion of serious study and sound scholarship for all students. A possible solution lies in a closer coordination and a better division of responsibility between the school and other youth serving agencies in the community.

Are Changes Needed in the Content of the Different Subjects Taught?

Because the special studies of the Curriculum Study are now in the process of developing suggestions for improvement in the different subjects of the curriculum, this area will not be discussed here. Time simply does not permit.

How Important Is the Role of the Teacher in Curriculum Improvements?

Administrators are recognizing that teachers must be protected from unnecessary duties and interruptions so that they can devote their attention to teaching. Also, the importance of a good learning environment and adequate teaching aids are being stressed.

Both in-service and pre-service training of teachers are coming in for more attention. So that teachers may teach subject matter better, emphasis is being given in their training to subject matter.

The curriculum is no more effective than the people who put it into effect. Good

teachers are essential if the curriculum is to be improved. In the words of *The Rockefeller Report on Education,* we should not "pin our hopes on education, business or cultural institutions, and lose sight of the fact that these institutions are no more creative or purposeful than the individuals who endow them with creativity and purpose."

IMPROVING INSTRUCTION IN ELEMENTARY SCIENCE *

JOHN EDWARD GARONE
Jersey City State College, Jersey City, New Jersey

UNLESS the teacher provides the energy of activation within the classroom little will be accomplished in the improvement of instruction in science. What the teacher thinks can be done will frequently determine what is accomplished.

If the complexity of an activity itself can be challenging then teaching today has more than its full allotment of challenge. Some teachers feel that keeping alert to new advances in subject matter or methodology in all areas of elementary instruction is becoming increasingly demanding if not beyond the realm of feasible achievement. In the words of one teacher: "At one time I tried to follow the pendulum. Sometimes I even climbed aboard it. Nowadays it swings so fast it takes all my strength and energy just trying to avoid it."

"Where do we find the time?" is another frequently voiced concern. Some supervisors are asked, "With all of the enrichment when is there time to teach reading, mathematics, social studies, and science?"

If some of these comments indicate valid concerns, is a possible answer teacher specialization of subject matter at the elementary level, with the inclusion of provisions for the social and emotional needs of children? Or, with the school day already so full is it time for some decisive selection making within the framework of a self-contained classroom?

Both possibilities have and will have their advocates. Proponents of specialization for elementary science will probably increase within the next few years. However, with either program many unresolved problems still have to be met. In either situation the teacher will become an increasingly significant participant in the study of curricula and the improvement of programs of instruction.

Some pertinent factors which can profitably be considered as teachers improve instruction in elementary science are the following: (1) the avoidance of obsolescence, (2) the study of children's development in science, (3) the efficient use of time, (4) the selection of learning experiences, (5) the motivation of learning, (6) the understanding of children's concept development, and (7) the improvement of children's thinking.

AVOIDANCE OF OBSOLESCENCE

It has been estimated that our acquisition of important scientific knowledge has doubled within the last decade. With the growing complexity of science and the ever-increasing amount of significant scientific information being made available, even a short respite in the selective acquisition of this knowledge leads rather quickly to a state of obsolescence.

Avoiding obsolescence has a number of ramifications. Keeping informed in science-related fields is one aspect. Learning of progress in child development and science education studies is another. A third is providing a kind of anticipatory education.

* Paper presented at the meeting of the Council For Elementary Science International, Hotel Jefferson, St. Louis, Missouri, April 3, 1959.

The maintenance of communication with the child's world is a fourth.

How do many teachers keep informed in science-related areas? There are a number of ways. Most teachers' desks contain a copy of their favorite professionalized science textbook, and this provides a basic overall reference for many areas of science instruction. In addition, local, city, and state courses of study provide further aids. Children's books are frequently consulted for the wealth of materials they can offer. The teacher supplements to children's periodicals as well as other newspapers and magazines often provide the most current coverage for science-minded teachers. In-service training and on-the-spot assistance from consultants and supervisors complement these sources of teachers' assistance.

Because every elementary teacher is a teacher of science an understanding and working knowledge of child development as well as science education literature becomes essential. The bulletins and magazines published by science organizations and colleges provide, in capsule form, much of what teachers want to know and have the time to read. Less frequently, more detailed journals are consulted for specific needs.

Unless proposals for educational changes in science instruction are anticipatory, an educational lag already exists at the time the changes are instituted. Recognizing the need to avoid crash programs and not desiring to jump on any bandwagons it still seems that at the present time it sometimes takes too long for schools to readjust some of their objectives, many of their procedures, and much of their content in relation to children's crucial needs. In many situations children have already outgrown the curriculum that is just beginning to be introduced. Most children are capable of learning much more than many science programs offer. In such situations, fortunate is the child who is capable of learning on his own.

Education must be anticipatory. The differences between our world and children's worlds although extensive are less significant than the differences between children's current worlds and the worlds they will face in the years ahead.

Teachers have to remain alert in order to retain contact with children's worlds. The teacher's goals, plans, procedures, and evaluations are dependent upon the knowledge and understanding of what is going on in the children's minds. How can teachers learn about children's development in science?

STUDY OF CHILDREN'S DEVELOPMENT IN SCIENCE

Many classroom activities provide opportunities for the fostering and for the study of children's progress in science education. Teachers can selectively use the procedures most effective for their own purposes. The manner in which a procedure is used is as significant as the procedure itself.

The following account will include some evaluations of three procedures used during an eight-year action research project. These descriptions can serve as leads to other teachers. Although any study of a group of children may provide comparable results, outcomes will vary depending upon the individuals studied, the procedures selected, and the ways the procedures are used.

Preparation of Anecdotal Records. The use of anecdotal records for the study of children's progress in science-related development enables teachers to: (1) make concrete observations of spontaneous behavior, (2) determine some of the children's actual experiences, (3) learn about their precepts, interpretations, and problem solving, (4) study concept development over periods of time, (5) detect significant trends or patterns of development, (6) gain evidence of change or lack of change, and (7) evaluate on the basis of actual experiences.

The validity of this procedure for the study of children's science-related development depends upon: (1) the accuracy of the teacher's observation, (2) the selection

of the behavior recorded, (3) the nature and extent of the environmental influences, (4) the objectivity of the written record, (5) the exclusion, or identification, of the teacher's interpretations, and (6) the experience of the recorder in the use of this technique.

Two examples of parts of anecdotal records follow:

AR—June 5—Grett
Once I thought that a brain looked like a dog bone. When I read a comic book and somebody had a brainstorm they would show a dog bone over their heads. I really believed it, although sometimes I got confused because I wondered how all my thoughts could fit into a dog bone. This year we learned about the brain, I was happy to find out that my brain isn't a dog bone.

AR—May 4—Bell
How did scientists and doctors find out which part of the brain controls each part of the body?
How could a person's eye be taken out if it belongs to the brain?

If time factors limit the scope of the recording possible, two procedures can be used. First, attention can be focused on a specific aspect of science-related development for an entire group of children. In this case, a definition of purposes provides for more specific recording and limits the field of study. Second, the study of only a selected number of individuals within a group can be undertaken. Because of the extensive amount of time and energy needed to record, interpret, and evaluate anecdotal records, it is proposed that teachers restrict their anecdotal record keeping to a specific limited aspect of science-related development during a particular period of time, or that they select a few children within the group whom they can study in greater detail over a longer period of time.

Use of Recording Equipment. Data concerning group science discussions derived from tape recordings are permanent, accurate, objective, and comprehensive.

Initially children are usually very much aware of the presence of the tape recorder. However, when the use of the recorder becomes a commonplace procedure little attention is paid to it.

This is a brief portion of a tape-recorded discussion dealing with the topic "I'm Not Afraid of Anything—Except. . . ."

TR—Feb. 23—Entire Class and Teacher
Grett: Well I think that people are really scared for the rest of their lives. Maybe not the rest of their lifetime, but a good percentage of it. I know, because when I was a little girl I fell down an esculator, and I hadn't gone on an esculator until this past week. I would never go down an escalator. I always went down the emergency staircase with my friends and everything, but I wouldn't go down the escalator.

Carl: Well, two years ago I cut myself with a chisel and I don't like to fool around, I mean chisel anymore. I don't like to take any more chances.

Debbie: Well, last year I cut myself with a knife, and I'm a little knife-shy.

Teacher: Not just careful?

Debbie: Well, yes, careful, but I keep away from knives whenever I can.

Bart: Well, this is pretty petty, but about two years ago in camp we were having a marshmallow roast and the counsellor was giving out sticks and mine had a beautiful curved shape. While I was toasting it, it rolled right down the stick and stuck onto my hand and ever since then I can't stand marshmallows.

Peggy: About five years ago I was playing with a cat, (at that time I wasn't allergic to them), and I suppose I was holding it too close and I don't know, I was wearing a thin cotton dress and I was holding the cat on my shoulder and I don't know if she bit me or scratched me, but it really hurt. I went to the doctor and he burned it out with some kind of acid, and now I have permanent scars on my back unless they are removed. But I don't mind still playing with cats.

Ed: But, Peggy, you just said you are allergic to cats.

Peggy: But I still don't mind to be near them.

The transcribing of a six-hundred-foot reel of tape usually requires from eighteen to twenty-five hours. Few teachers have the time to allot to this activity. Teachers can benefit from the use of the tape recorder and avoid this time consuming factor by listening to a playback of the recording. They can thereby learn a great deal about the nature of the discussion and its participants. Teachers can listen critically and carefully to an exact recording. They can replay specific significant parts. They can evaluate their role as a participant, and they

can analyze children's behavior more objectively.

Written transcriptions, once prepared, make it much easier to analyze the many factors pertinent to the discussions. It also provides a more convenient means of communicating the content of the recordings to others.

Collection of Children's Writing. Children's writings provide an open channel for communication between each child and the teacher. Children identify this procedure with an element of privacy. They frequently state that there are many thoughts and feelings that they prefer to communicate to the teacher in writing rather than in a face-to-face relationship. Since the children's communication through this medium was so extensive it is believed that future investigations concerning this kind of behavior would be most significant, particularly in regard to the frequently described inaccessibility of children in the upper elementary age group.

Here are two excerpts taken from the children's writing:

CW—June 5—Peggy

Whenever someone gives me some criticism which might help me improve my faults I do not become insulted. Instead, I really appreciate it, because it may help improve my character. But sometimes some children in our class tell me things which I really can't help and that just gets me furious. The other day a boy in the class told me I had very many pimples on my face (as if I didn't know), and asked me if I had the measles. Then he said, "The best way to get rid of them is to scrape them off." I do all I can to keep them from increasing, but sometimes it just can't be helped. But that he had to tell me how to get rid of them really got me angry.

CW—June 20—Bart

Lots of things I hear about science or related subjects are things that everybody usually *thinks* they know about, but it turns out wrong. Many times I read things, especially about electricity when all of a sudden I read in a rather good book (and reliable book) that it wasn't. I forget the examples because they got me mixed up. Whenever I read something that everybody knows, I wonder if it really is.

The collection and study of children's writings are very useful and offer many advantages. They already exist in written form and are, therefore, permanent records. They require little time to read. They are as accurate as the children make them. They can be relatively unstructured, and useful as a projective technique. Teachers will find this technique, with its many applications and variations, valuable for many different kinds of research.

Children's worlds are much better understood when the teacher knows more about them. Action research as teaching provides a direct opportunity for improving instruction in elementary science. The appropriateness of the teacher's assistance on the line of action is determined by his success in ascertaining the specific needs of the children.

EFFICIENT USE OF TIME AND TIMING

Efficiency of time usage is a basic concern of the classroom teacher. With responsibilities to the individual and to the nation becoming more pronounced, every moment of school time has to be used wisely. In addition, timing and pacing of children's experiences are required in order to lead to most efficient learning. Knowing just when to phrase a question, recognizing when silence will accomplish most, challenging sometimes and supporting other times are all marks of efficient as well as skillful teaching.

In terms of economy of time teachers employ many procedures which lead to efficiency of teaching. Reading activities from time to time deal primarily with science-oriented materials. Science-related experiences often form the basis of children's written experiences. Oral expressional opportunities contribute to self-understanding, learning of content, changing of attitudes, and the development of skills.

Knowledge of the learners by the teacher can lead to greater rapport with consequent conservation of energy which might have been necessary to resolve conflicts and to eliminate feelings of antagonism. Efficiency of learning results in the saving of time which can be allotted for more creative pursuits.

SELECTION OF LEARNING EXPERIENCES

Of the multitude of concepts, skills, and attitudes which can be developed in elementary science, teachers usually try to select those that will have the greatest permanent value for the children. There appears to be a basic need for an evaluation of available research, as well as some new research, on what children should study in elementary science at the present time and in the foreseeable future. The selection of specific learning opportunities becomes increasingly significant as our storehouse of scientific knowledge grows. Can more direct routes to the formation of generalizations be established? Does the duplication of experiences retard progress needlessly? Gradation and articulation within a school is a necessity.

Teachers recognize that abstract concepts can retain children's interests over long periods of time. When a teacher casually asked, "Which is larger in size, the electron or the proton?" the children were prompted into more activity than had been brought about by many previously planned or child-initiated programs. No direct study or experimentation by the class was possible, but few sources of information were left untapped. Reference materials contained conflicting information, and diagrams and charts in most books led to further confusion. The children's theorizing, sometimes accompanied by gross misinterpretations, led to many very valuable learning experiences, understandings, and appreciations. The word, "authority" gained new significance. The need for motivated patience was experienced. The structure of the atom was studied in great detail.

Even when teachers plan very carefully for the selection of learning experiences, it is often necessary for teachers to adapt to on-the-spot experiences brought up by children. Sometimes children do not derive the same benefits from an experience which a teacher momentarily anticipates they will gain. During a class discussion in which Judy was speaking the teacher's thoughts were focused on the science-related learnings implicit in her statements. This is what she was saying:

> Once I read a comic book which had an experiment in it about fire. The experiment showed that if you put an egg over a bottle with a small neck, and put fire in the bottle the egg will fall through. I thought that the fire must be put under the bottle for it to expand.

At this point, the discussion leader asked Judy what she had learned from this. Judy answered, "I think this observation proves how much you can learn from comic books."

MOTIVATION OF LEARNING

Improving instruction means improving achievement. Because motivation is so intricately related to achievement, any attempt to improve instruction has to capitalize on motivation.

The kind of inspiration that impels a child to look beyond the limits of the readily accomplished is what we need in science instruction. If a child's behavior is inherently motivated by a desire for the fulfilment of enduring and fundamental pervasive drives then his progress in science-related activities is for the most part assured.

Unless potential ability becomes functional ability little progress can be made. Some children exhibit more of a drive toward science-related pursuits than other children. For most children environmental and cultural factors tend to provide an impetus to their inherent drives. Even strong motivation requires constructive direction if waste of talents and opportunities are to be avoided. Sensitivity to children's innate abilities and real needs is a safeguard against unreasonable demands and expectations.

Classroom teachers have to guard against science education for mediocrity. Underachievement in relation to total pupil potential can frequently be avoided by keeping alive the desire to learn.

It is probably in the area of children's scientific concept development that teachers can make their major contribution to the improvement of instruction.

UNDERSTANDING CHILDREN'S CONCEPT DEVELOPMENT

During recent years interest in the study of human thought processes has increased. Both psychologists and educators recognize the significance of concepts in learning and thinking. Although accounts of cognitive processes vary, there is agreement that the development of concepts is fundamental to both learning and thinking. It is proposed that if a teacher is cognizant of the concepts and the conceptual development of the children within the class he can more effectively help the children to improve their conceptualization. Consequently, the teacher's science instruction is improved.

Individualization of Experience. Certain physiological, emotional, intellectual, and social differences influence a child's scientific concept development. The uniqueness of the individual combined with a variety of environments further contribute to the individualization of experience. The careful study of a group of children by a teacher reveals extensive evidence of specific individual differences.

Children's Concepts. The concepts of all children are unique and individualized. Even when a group of children participate in common experiences their individual perceptions, interpretations, and concepts are different. The following illustrates this point. During a discussion of why the plants did not grow well in their classroom, one child stated that it was because the room received no sunlight. He added that the sun was necessary for photosynthesis. Six months later during a discussion of the importance of the sun to the earth, Todd, another child, stated that photosynthesis took place on the sun. When questioned, he quoted the statement he had heard six months earlier; namely, that the sun was necessary for photosynthesis. Therefore, he concluded, "Photosynthesis takes place on the sun."

It is not uncommon for a person to assume that his perceptions, interpretations, and concepts are the same as those of others. This is an erroneous assumption. The recognition of the differences of perception, interpretation, and, of course, concept development can help to improve personal relationships and further mutual understanding among teachers and children.

Children's Environments. Because environments differ a primary concern of education is to help children gain a functional understanding of their environments. Education can also assist them in learning how to modify or to change their environments in order to make them better places in which to live. Few will question the value of this objective. However, what constitutes children's environments?

From a physiological point of view it is difficult to distinguish between the individual's external and internal environments. Is oxygen a part of the body when it enters the mouth or after it has been dissolved in solution and has passed through the lung membranes? Psychologically an individual is just as intricately related to the environment. It is proposed that the interaction of a child with his environment is within as well as outside the individual. All too frequently children have studied science as though they were *apart from* the environment. Children should be helped to recognize themselves as integral parts of the environment.

The importance of the study of objects and phenomena cannot be denied. However, it is not only what is in the environment, or what happens within the environment that is significant, it is how the children perceive and interpret what is in the environment that determines the kinds of concepts they develop. If their perceptions are inconsistent with reality, or if their perceptions are accurate and their interpretations are incomplete or decidedly erroneous then their concepts are consequently characterized by diminished validity.

Again this indicates the importance of the teacher's knowing what children perceive and how they interpret what they

perceive. If a teacher learns what children perceive and how they interpret what they perceive he can help them to develop concepts in accordance with the best available knowledge and experience.

Concepts and Communications. Communication is a basic dimension of understanding. For example, during a discussion Pennie described a trip she had taken in what she termed a "new duplex airplane." In her statement to the class she said, "I went in one of those planes with a top and bottom." Ted immediately interrupted and with intense sincerity stated, "How else could you stay in it?"

If nothing is exactly the same to all children then many concepts and feelings children have are unique and individualized. It is frequently difficult to determine what children think and feel. The differences in meaning attached to concepts can often be a barrier to communication. Ineffective communication also hinders understanding.

Communication is more effective sometimes than at other times. There is usually some reliable interrelationship between the existing concept and the word sequences utilized. This does not imply that a concept is merely the capacity to use words with some degree of understanding; however, it can be assumed that the effective manifestation of concepts depends very significantly upon the use of words as communication media.

Communication can become more effective if the teacher understands his children and provides a variety of opportunities for them to recognize their numerous roles and environmental interrelationships. If by communication the teacher is able to ascertain the concepts the children have previously developed, he can more efficiently plan for future learning experiences.

IMPROVEMENT OF CHILDREN'S THINKING

The development of thinking has to be made more intricately a part of our total educational science program. A study of children's scientific concept development led to the following conclusions pertinent to children's thinking.

Recognizing the Percolation Involved in Thinking. Sometimes periods of time elapse between the development of concepts and their application. The following three statements made to the teacher indicate some of the percolation of thoughts in a child's mind.

In September, Grett stated, "I have always been very depressed because I weigh so much." In January she had learned that "weight is the amount of pull gravity has on objects toward the center of the earth." In April she commented, "It just occurred to me if weight is the amount of gravity pulling on an object toward the middle of the earth then there's more pull on me than most children my age. You know it's not so bad to be heavy if you think of it that way."

Concepts are not always arrived at directly. There is frequently much thought which precedes their final development. It is important for teachers to realize and appreciate how much children work with their experiences before they derive satisfactory understandings.

Fostering Children's Thinking. The interplay of concepts and experiences can result from individual thinking or it can result from the activating influence of other people's thinking and experiences. Because this reorganizing and re-evaluating of concepts and experiences can offer children so much in terms of their scientific concept development it should be encouraged as a part of effective science education. Planning and organizing experiences for individual and cooperative learning can energize this total process.

Encouraging the Expression of Children's Thinking. Children need ample opportunities for the expression of their percepts, interpretations, and concepts. Science education can provide these opportunities.

As occasions for honest expression are provided children can learn appropriate ways of indicating their thoughts and feelings. With this expression, the inter-

play of children's thinking is made possible, and the communication of thoughts is facilitated.

When children feel free to express their own thoughts they gain a new dimension for independent thinking. Rigid restrictions to the mere acquisition of facts are consequently avoided.

There is a kind of mental activity which goes on within the minds of the children within every classroom. It is the teacher's responsibility to provide the kinds of experiences and encouragement that will foster the expression and development of this thinking.

Providing Time and Opportunities to Think. It is possible for adults to become so concerned about providing a multiplicity of learning opportunities that they tend to overorganize children's activities. When time is limited, the time devoted to thinking is sometimes shortened. It is important that children have time to think about, and to evaluate, their experiences. Teachers can plan to allot specific time for experiences that depend upon individual thought and action.

If the full potential of children's ability to think independently and creatively is not always achieved, one of the fundamental contributing causes is the deprivation of time needed for this purpose. It is well for all of us to remember: He also learns who sometimes sits and thinks.

ACQUIRING KNOWLEDGE AND ATTAINING UNDERSTANDING OF CHILDREN'S SCIENTIFIC CONCEPT DEVELOPMENT * †

JOHN EDWARD GARONE
Jersey City State College, Jersey City, New Jersey

CHILDREN'S SCIENTIFIC CONCEPTS AND CONCEPT DEVELOPMENT

CONCEPT development is essential to effective thinking and learning. Because concept development is so intricately related to children's total development, teachers and parents need to know and understand more about it. If adults acquire knowledge about and improve their understanding of children's scientific concepts and concept development they are better able to help children to improve their science-related learning and thinking.

Objectives of This Study. The principal purposes of this study were: (1) to present and to illustrate a general approach to the study and the improvement of a group of children's scientific concept development, and (2) to describe and to analyze what was learned about the scientific concept development of a group of twenty-nine children through a study of their percepts, interpretations, and problem solving. The children studied were ten to twelve years of age, and of superior intelligence.

Definition of Terms. Concepts represent the ultimate essence of past experience, and provide the embryonic structure for present and future experiences. *Concepts* are organizations of experience. They are individualized networks of mental configurations. Concepts vary in complexity. The development of a concept is an intrinsic process.

It is proposed that concepts arise as an individual experiences the environment and interprets what he experiences. The term

* Paper presented at the Thirty-Second Annual Meeting of the National Association For Research in Science Teaching—Council for Elementary Science International, Hotel Dennis, Atlantic City, New Jersey, February 21, 1959.

† Based on the author's dissertation for the degree of Doctor of Education, Teachers College, Columbia University, 1958.

percept is used to designate the individual's immediate experiencing of the environment. The term *interpretation* is defined as the explanation, clarification, or evaluation which he makes. Concepts are integrations and organizations of percepts and interpretations. Percepts, interpretations, and concepts are intricately related to the recognition and solution of problematic situations.

NATURE OF THE STUDY

The Procedures Selected. The procedures selected were: (1) the preparation of anecdotal records of children's percepts, interpretations, problem solving, and concepts; (2) the use of tape recording equipment to provide objective accounts of a variety of verbalized group activities; and (3) the collection of the children's written materials.

Organization of the Study. The data supplied by the children were organized and analyzed in terms of the experiences and processes fundamental to children's scientific concept development. The study of the children's percepts and concept development provided detailed evidence of the children's immediate experiencing of the environment. The children's interpretations, questions, feelings, and superstitions were studied as they related to concept development. In addition, the children's problem solving and concept development as well as specific illustrations of their problem solving processes were examined. Permeating the entire study were suggestions as to how teachers can attain understanding and provide the opportunities and the guidance that will help children to improve their problem solving abilities and their scientific concept development.

PERCEPTS AND CONCEPT DEVELOPMENT

Percepts provide the materials for concept development. In perceiving, the individual develops an awareness of, and a relationship to, the external environment. Perception usually initiates concept development.

Child's Writing—April 16—Carl

This Saturday Roger and I went to Town Park and took a ride on the boats.

I observed many new things that I never even heard about. I saw a rock that looked as if it was there during the Ice Age. As we climbed over hills we could see many cases of erosion.

We also saw a graveyard on a hill near part of the bridle path.

As percepts are acquired concepts are developing. In this way existing concepts can be influenced or new ones established. What is retained from past experience will influence what children perceive and how they perceive. Past and present perceptualization of experiences will help to determine the kinds of concepts children develop. The following account indicates a child's recognition of how concepts are influenced by what one perceives.

Child's Writing—May 7—Ava

My great-grandma who is about eighty-seven is now going deaf. She has to turn her television very, very loud, and when she does the people in the next apartment complain of their walls shaking.

This Saturday we went to my Uncle and Aunt's house and she came with us. For dessert we had ice cream cake, and because we were talking in a normal tone she could not hear us. You have to scream in order for her to hear. My uncle was trying to cut the cake, but because the ice cream was so hard he was having trouble cutting it. My great-grandma didn't know that it was ice cream, but thought my aunt had made it because we were fooling around about it, and she thought it didn't turn out.

When we found out what she thought it was very funny. But I feel very sorry for her.

Concepts tend to link, classify, and organize percepts. The interrelationships of the children's percepts to the development of their concepts are intricately described within the study.

INTERPRETATIONS AND CONCEPT DEVELOPMENT

Interpretation is fundamental to concept development. Concepts also influence children's interpretations. Interpretations enable children to make generalizations concerning percepts. Reliable, consistent, and coherent interpretations contribute to reliable, consistent, and coherent concept de-

velopment. If the concepts children develop are valid they provide the theoretical framework into which additional perceptions and interpretations can be assimilated. But, unfounded interpretations can be real to children. The records contained numerous examples of unfounded beliefs. It is significant that the children could frequently substantiate their unfounded statements by referring to specific experiences. One example follows:

Anecdotal Record—Nov. 2—Brad

When a knife falls a man is supposed to visit you. When a fork falls a woman will visit you, and a spoon can be anyone—or anything. I honestly believe in this superstition.

One night while cleaning up supper dishes, my sister dropped a knife. Twenty minutes later while watching television the doorbell rang. In walked my father's friend—a man of course—to discuss something.

Another time my mother dropped a fork and a woman came.

I must say it doesn't work all the time. Nothing ever happened when a spoon falls with me. Maybe something will happen one of these days—I hope not.

Do you believe in this superstition? Many people do. It doesn't work if you purposely do it.

Children's experiences are not always adequate to enable them to make consistently valid interpretations. When teachers gain insights into children's experiences they can help to clarify the experiences, challenge the thinking, and improve the learning.

PROBLEM SOLVING AND CONCEPT DEVELOPMENT

Concept development permeates all aspects of problem solving. Problem solving and concept development have a past, present, and future dimension. It is as a consequence of the experiences of the past and the activity of the present that the creativity for the future is made possible.

It was found that by providing the children with problem solving experiences within their level of ability and comprehension, and by making the children aware of the values of reliable procedures and critical attitudes their problem solving abilities and their concept development were improved. Some of the ways teachers can work with children to help them to develop their capacities to identify problems, to propose hypotheses, to experiment, to evaluate findings, and to draw conclusions were described in the study.

SOME CONCLUSIONS

Some additional conclusions follow:

Under suitable conditions children will share many of their percepts, interpretations, problem solving activities, and concepts with others.

It is reasonable to assume that with appropriate adaptations, teachers can use the methods described in this study to learn about, and to improve, the scientific concept development of any group of children, and to better implement any science curriculum.

All the children needed guidance at some time in developing scientific concepts. They particularly needed help in separating fact from fiction.

Concept development as a categorizing activity was repeatedly manifested. Note the searching for acceptable categories in the following questions: "How can June twenty-first be the longest day if it has only twenty-four hours?" "Why does a potato get soft and an egg hard when each is boiled?" On the basis of their categorizing the children recognized inconsistencies or inadequacies in their organization of inferences. They needed additional experiences to help in exploring and resolving their apparent confusion. They needed help in developing concepts.

Concepts are not always arrived at directly. Frequently, much thought is involved in their development. It is important for teachers to realize and to appreciate how much children think about their experiences and work to integrate them into satisfactory understandings. Sometimes long periods of time elapse between the original experiences, the development of concepts, and the application of the concepts.

The children engaged in all aspects of problem solving; however, the order in which the various aspects of problem solving were engaged in did not consistently follow any specific sequence.

There is a kind of mental activity which goes on within the minds of the children within every classroom. It is the teacher's responsibility to provide the types of experiences and encouragement that will foster the expression and development of this thinking.

With children of superior intelligence, as with all children, some balance should be maintained between providing available answers and information and helping children to obtain information on their own. If a child is redirected to use his own resources and if the child finds this impossible his interest can be thwarted. Similarly, it is human waste not to help children develop their capacities to explore and to find out on their own, or to solve many of the problems they are capable of solving. The significance of knowing what children's concepts are and how they use them will help the teacher to decide whether or not a child is capable of obtaining the goal for which he is striving, and the extent of the assistance which he might require.

The children's innate intellectual capacity, perceptive ability, competency for making interpretations, eagerness and capacity to recognize and to solve problematic situations, and the quantity and the variety of pertinent experiences significantly influenced their scientific concept development.

When working with a group of children for almost a year it is not difficult to select those children who at the age of ten or eleven already exhibit highly advanced science-related interests, extensive knowledge of specific areas of learning, innate capacities to think independently and creatively, and ability to solve problems with optimum efficiency.

The unifying theme of mental health and science education was repeatedly recognized. There were many psychological understandings that the children acquired through science-related experiences.

SOME IMPLICATIONS OF RESEARCH FOR THE PREPARATION OF PRIMARY TEACHERS *

CLARK HUBLER
Wheelock College, Boston, Massachusetts

In regard to research in science education for the primary grades the first impression, if we are willing to admit it, is likely to be that the research has little effect on the practical-minded teacher interested in planning tomorrow's lesson. The inexperienced undergraduate likewise finds little that is meaningful in the reports of research. The inconclusive and conflicting results of various studies make interpretation difficult even for people experienced in the field. Studies of children's interests provide a good example, for evidence can be found in these studies to substantiate almost any position a person wishes to assume. Looking beyond these examples at the whole field, we find much chaff with the wheat. As a result, students of science often scorn all of educational research and methods, concluding there is nothing to either of them. Actually the field is complex, rather than simple as at first assumed, and the difficulties encountered are the result of that complexity. How

* Paper presented at the Thirty-second Annual Meeting of the National Association for Research in Science Teaching—Council for Elementary Science International, Hotel Dennis, Atlantic City, New Jersey, February 21, 1959.

we teach does make a difference, as anyone who has sat in the classes of various instructors can testify. To see the influence of research on educational procedures it is necessary to take a long-range view.

SOME CONTRIBUTIONS MADE THROUGH RESEARCH

As we look back thirty years we can see that Gerald Craig's doctoral thesis and the course of study developed with it have provided the essential outline of the work undertaken in elementary science almost everywhere it is taught as an organized program. Text books likewise follow it with but comparatively minor variations.

Studies of child psychology have brought about many changes. During the nineteenth century attempts were made to introduce science into the general curriculum, but with little success. Before the days of Nature Study science was a highly formalized subject that proved too formidable for elementary children and their teachers as well. Scientists contended that progress in the exact sciences came from attention to detail and that mathematical derivations were indispensable. The discoveries of Lavoisier often were cited as examples to show that only through careful measurements would relationships become apparent. Accordingly, science for children had to be taught with substantially the same emphasis on detail. But with studies of child development to provide justification, the modern movement in elementary science has stressed a developmental approach in which the child is encouraged to investigate in accord with his own natural impulse, and the first learnings are likely to be largely qualitative. Greater depth and exactitude comes later. Even Lavoisier could not have begun with the discoveries that made him famous, but necessarily had to develop his skill and insight. Studies of child development have had and are having marked influence on all of education, but perhaps more on our field than on any other.

Studies of children have resulted in a new emphasis on the child's natural curiosity, and accordingly the "sugar-coating" and romanticism once thought necessary has been discarded in recent years. Alice Williams' study of *Children's Choices in Science Books*, no doubt has been a factor in that change, influencing publishers and teachers alike, helping to substantiate opinions derived from general experience with the children themselves.

Mervin Oakes in his *Children's Explanations of Natural Phenomena* concluded that children give explanations which are naturalistic, in terms that are concrete and immediate—in contrast to the common view that fantasy was appropriate to childhood, and that ability to reason developed later. The study by Oakes did not revolutionize education singlehandedly overnight, but it has helped. Social changes come slowly. Numerous studies of the problems teachers face in science have shown that teachers consider the lack of adequate teaching resources one of their greatest obstacles. Here is a situation that even now seems to be going through the initial stages of change resulting from research in science education.

Often the first to be influenced are the leaders in the field. At conferences such as this it long has been popular to stress the desired emphasis on commonplace teaching materials by saying that all the materials needed for a science program can be found among the things a normal boy carries about in his pockets. In the same vein, one of the most discerning and capable persons in our field, Herbert Zim, made an often quoted statement in *This is Science,* published in 1945. He said:

> The only real equipment needed to help children with science experiences is a willing and alert teacher. So much can be done by observation and by activities without any equipment whatsoever that the question of materials need have little importance in providing science experiences for young children.

In contrast, nine years later, in *Science for Children and Teachers,* Zim wrote:

While the use of simple equipment and of pupil participation in getting it is commendable, it represents an oversimplification of the problem. The best science teaching will not be achieved until the question of materials is reconsidered in the light of the value of children's activities and the most effective use of the teacher's time. . . . A common assumption is that he (the teacher) will independently obtain whatever equipment and materials he needs by whatever means available. This assumption just doesn't fit the realities of life and often reduces science to the level of just another reading lesson.

Educational research influences the leaders in the field. Others are affected by their opinions. It is a long process, but ultimately we find conscientious and capable teachers using the ideas; other teachers learn from their neighbors when an example is set. When children from such classes themselves become teachers they find it quite natural to teach as they have been taught. Ultimately the public expects and demands the more effective procedures which were initiated years before through educational research.

SOME FINDINGS FROM OTHER FIELDS

We learn from research in allied fields, as well as from our own. In the August, 1958, issue of *Scientific American,* Irving Rock describes experiments in psychology which indicate that associations form instantly, rather than gradually with drill. The findings may suggest a new approach to drill subjects, and also may substantiate our belief that strivings for understanding through science—seeking meanings, relationships—is the more effective way to learn. For example, science can be a stimulus to the entire language arts program, including reading, and the need for drill greatly reduced. Children can learn to read, write, and speak in meaningful situations. Likewise, present-day studies of brain waves and similar investigations in neurophysiology may shed light on learning processes and suggest more effective procedures in the classroom. Here too the efforts of many research workers combine to provide a clear picture; progress comes slowly through patient investigations and a pooling of the findings.

SOME LIMITATIONS OF RESEARCH

Research in science education provides valuable evidence, yet seldom if ever gives definitive, conclusive answers to problems. Our tendency to use as proof a single study which substantiates whatever opinion we already hold is open to serious question. It is akin to seizing upon results in a natural science experiment that turn out "right" in a single instance and ignoring all the results which we consider "wrong." The results of investigations should be cited, but in as complex a field as this the statements should be conservative, exaggerated claims avoided.

Our standards should be raised somewhat to eliminate, or at least not publicize, the weak and ineffectual studies which merely clutter the field and discredit all educational research. A study with 45 test scores, divided into several categories can make a mockery of detailed statistical analysis, even though the 45 treated as a whole may form a worthwhile straw in the wind. Some form of cooperative research might help to make large problems amenable to individual efforts. The assumptions made or the context in which a study is conducted can render it valueless for people who do not accept the assumptions or would not chose to work in the same context. Grade placement studies, for instance, often assume that a questionnaire will identify children's interests and thereby determine the proper grade level for a given concept. Studies of vocabulary difficulties likewise assume an unknown word is a reading hazard, yet in other circumstances concurrent experience can build a meaningful vocabulary from these previously unknown words. The limitations of studies based on the opinions of experts should be apparent. Opinions merely reflect the present status, and a general opinion can reveal only ideas already accepted.

SOME POTENTIALITIES OF RESEARCH

If research in science education is to function in its proper role it should be at the

forefront of new developments, and some studies do provide beacons, pointing out that science can be used with small children to teach reading effectively, that interest in science begins early, and that we need more physical science instruction in the early grades.

The number of studies which help to validate recommended procedures, or to raise appropriate questions, are not as common as they might be. Studies could be used to stress the new demands for excellence and to find which procedures are most likely to attain the desired goal. The value of observation and experimentation by children—in terms of attitudes, depth of insight, the degree of transfer to life outside the school, and the adaptability to individual differences, especially today as provision for the gifted, could be clarified by further research. The effectiveness of reporting as a pooling of ideas and as a stimulus to further efforts, also the relative effectiveness of various ways of reporting, could likewise be checked. It would be helpful to have one or more studies to locate situations in the history of science that have bearing on the problems of today—to point up the need in general education, especially in the preparation of teachers. Worthwhile studies could be made of research in science education to find trends, to locate points of agreement and points where issues remain, to seek relationships with advances in psychology and other fields, and to note the effects on teacher training. Descriptive reports of effective classroom procedures in the preparation of teachers or in work with children, including whatever objective data can be obtained in such an organic approach, should be encouraged. The status studies are useful, because students should realize the strong programs we advocate are not already common, and accordingly must be built, not merely assumed. Status studies ought to indicate possible solutions, as well as to define present conditions and locate problems.

Although the implications of research are complex for the student with but one course in the teaching of science, an awareness of such studies can be developed through individual reports, or better yet, through a panel discussion of the professional literature in science education applicable to the primary level. If written reports are used to interpret practice teaching situations and indicate desirable improvements, the professional literature, including research can be used to document the student opinions and thus aid in bridging the gap between theory and practice.

WHAT PREPARATION HELPS THE TEACHER TEACH FOR PERVASIVE OBJECTIVES? *

GROUP III REPORT

In the discussion group having Dr. Challand as Leader, the problems of teaching meaningful science to children and the pervasive objectives of such a program, were explored. The basis for the discussion was Will Burnett's book, *Teaching Science in the Secondary School.*

According to Burnett, the over-all responsibility of the science teacher in a great democratic society is to challenge, stimulate, guide, and assist young people to develop the understanding, critical abilities, attitudes and viewpoints that really represent the best in both the scientific and democratic traditions. This over-all responsibility can be broken down into four general areas of classroom activity:

1. Academic or college preparation.
2. Vocational or practical knowledge.

* National Association for Research in Science Teaching—Council for Elementary Science International meeting, Hotel Dennis, Atlantic City, New Jersey, February 21, 1959.

3. Critical thinking.
4. Inner unity or emotional and ethical maturity.

While it is considered that every teacher should have a sufficient subject matter background in the area or areas in which they desire to teach, it is equally important that prospective teachers be exposed to, and participate in situations that demand both the critical analysis and thoughtful solution of meaningful problems.

Often times when setting up the objectives for class instruction, we become confused between pervasive and content objectives. The pervasive objectives are the many attitudes and appreciations that arise directly out of real life problems or situations. Actually teaching should liberate intelligence, and should result in the freeing of the mind through the mastery of reason over the things learned. Some teach the pervasive objectives indirectly and some teachers feel that they are not really taught, in the formal sense, but are the natural outcome of good teaching.

What are some of the general problems that most of the teachers are faced with? First, how to teach the children and second, how to evaluate what they have taught in terms of their predetermined objectives?

One interesting point which was made, concerned the pupils whom each teacher had to teach. Often times, as teachers, we tend to forget that each age child has certain problems peculiar to his age. Each age group looks at things from their own "unique" point of view, and not from the adult's. Why not, for the child is not an abridged, miniature adult; especially in the psychological realm.

It was also pointed out that you could teach pervasive objectives by being consciously aware, of the relationship that exists between the class work and the pupil, and taking every opportunity to bring the child into the complete picture. You, as the teacher must know what you are teaching for, and then consciously strive for it and, often indirectly, you will achieve even more significant results.

Attention was also focused on the fact that teachers must be consistent in their teaching, whether it be in the area of science or social studies. If we are striving to have the pupils do a little creative thinking on their own, we must carry it on in all the subject areas that we teach. Every good teacher gives some attention to the intangibles as well as the more obvious subject material outcomes. Teaching pupils to be self reliant and thorough are virtues that can benefit all subject areas.

When we teach problem solving, we can also directly teach for the intangibles related to such operations. We ask the pupils to examine the nature of the problem, and then if they can, step outside of the immediate area and try to view the problem from the outside. If you can determine the nature of the problem, you should be able to directly or indirectly evolve a solution to it based on past experience and synthesis of the underlying laws or factors.

One of the previous research papers given today, pointed to the fact that most of the teachers contacted have not had methods courses in their college preparation for teaching. It is only recently, with the development of methods courses concerning the history and appreciation of science, that teachers have been equipped with a more comprehensive view of the subject they will teach.

Discussing the different methods of delivery in a classroom, it was agreed that the lecture method was not dead, but in so many instances, just overworked. It was stated that the lecture type could be an effective way of transferring thoughts to pupils, but that much consideration must be given to the level of the pupils to receive it. This is especially true in the elementary grades.

It was also pointed out that one of the important roles of any teacher is to encourage the pupils to ask questions they wouldn't normally ask. It was pointed out that the art of questioning should receive more study and that the teacher should ask questions with the idea of reviewing and pointing up

the more important points of the lesson. The questions shouldn't have just categorically stated answers, but should elicit some thought. John Dewey is credited with the idea that we learn by what we have done and reflecting on what we have done. It is not just by doing, talking, etc., but a large measure of learning involves actual thinking on the part of the student. The important thing to remember is that the teacher must structure the situation so that the student can produce.

A point that was stressed was that it is the job of science to teach for objectives other than scientific. This is quite important, for often times people talk as though a scientific study was just a technical skill and not a thinking and general academic discipline.

In many secondary schools, teachers are often times hindered by administration and facilities. Many science departments do not have adequate science materials or labs, but much progress is under way. The lack of communication between teachers results in much waste or misuse of the materials that are available. It is not that the teachers knowingly misuse the materials, but that the pressure to have them do things without adequate preplanning, results in many makeshift solutions. The teacher is often times not aware of the over-all existing situation in the school and the hidden stores of materials that have been collected over the years by some of the "far sighted" teachers.

We concluded with an interesting thought about the development of a psychological lab for prospective teachers, so that they could see just how children at different ages behave and look at different situations. We as adults often expect totally different results than the children do because of our preconceived notions of how children should think and not how they actually do.

These thoughts were also reviewed at a general session which followed the individual group discussions.

ROBERT A. WEHRER,
Recorder

THE DEVELOPMENT OF AN INSTRUMENT FOR EVALUATION OF ELEMENTARY-SCHOOL SCIENCE * †

EVAN C. RICHARDSON
Newark State College, Union, New Jersey

THE problem of improving elementary-school science required an appropriate evaluative instrument. A study of the kinds of instruments for this purpose and of the responses to letters related to the subject to experts in the field, indicated that a suitable evaluative checklist of some kind was needed.

In the report which follows three subdivisions will be used: (1) identification of the checklist items, (2) validation of the items, and (3) summary.

IDENTIFICATION OF THE CHECKLIST ITEMS

The procedure used was one which selected six criteria basic to the objectives of elementary-school science and to the psychology of learning. The criteria selected were: (1) learning tools for science, (2) scientific attitudes, (3) scientific problem-solving skills and aptitudes, (4) individual differences, (5) evaluative techniques, and (6) facilities and materials. These criteria,

* Paper presented at the Thirty-second Annual Meeting of the National Association for Research in Science Teaching—Council of Elementary Science International, Hotel Dennis, Atlantic City, New Jersey, February 21, 1959.

† Based upon the author's doctoral study at Rutgers University *Proposals for the Improvement of Elementary-School Science.*

representing the foundation program for both classroom and the entire school, imply checklist items aimed at these two foci.

Abbreviated statements of each item will be found below. The percentage ratings at each of the major grade levels, K–3, 4–6, 7–8, of the elementary school represent the ratio of the pooled juror ratings, made by members of the Second Jury, to the highest possible score for the item at each level.

SECOND JURY POOLED RATINGS OF 50 ITEMS OF EVALUATIVE CHECKLIST

Item No.	Briefly Phrased Interpretation of Each Item	K–3	4–6	7–8
		(Percentage Ratios Are of Points Assigned to Possible Scores)		
		Per cent	Per cent	Per cent
1.	Teacher avoids giving answers in many science problem situations.	58	75	79
2.	Use of a science demonstration frequently to introduce here-and-now realism.	88	89	89
3.	Use of science experiences of short or/and long-term span.	87	96	100
4.	Use of experiments specifically intended to find an answer to a science problem	92	96	96
5.	Science problems come from the "failures" or the unexpected happenings.	82	87	87
6.	Use of trips to make a process or some science phenomenon become more real.	93	93	93
7.	Use of resource visitor to assist in study of science problems.	83	83	88
8.	Children use many kinds of written sources of science information.	71	79	88
9.	Children ask out-of-class authorities for science problem information.	83	96	96
10.	Children write away for answers to their science problems.	58	75	79
11.	Children and the teacher take frequent evaluative backward looks.	75	87	96
12.	Children anonymously evaluate their teacher and the learning methods used.	13	36	43
13.	Teacher evaluates child's progress in the development of various scientific attitudes.	96	100	100
14.	Teacher evaluates child's progress in development of various specific scientific skills and aptitudes.	96	100	100
15.	Strives for development of awareness of difference between fact and opinion, preconceived notion, or bias.	88	92	97
16.	Strives to build program actions to develop critical thinking.	93	93	97
17.	Teacher strives to use experience aimed at development of openmindedness.	83	93	97
18.	Teacher strives to use experiences aimed at the development of understanding of mechanistic causative relationships.	88	95	95
19.	Teacher strives to use experiences to develop awareness of the error in bias, prejudice and preconceived notions.	63	81	95
20.	Teacher continuously strives to have a child state the science problem being studied.	79	96	95
21.	Teacher continuously strives to have the children hypothesize.	77	95	95
22.	Activities used develop awareness of the need for observations and records of the observations.	92	100	100
23.	Teacher uses experiences to emphasize the need for delay in decision making.	59	87	97
24.	Children continuously try to find ways of using experiment-control procedures.	85	95	95
25.	Children help to determine the purposes and activities of the science program.	87	95	95

Item No.	Briefly Phrased Interpretation of Each Item	K–3	4–6	7–8
		(Percentage Ratios Are of Points Assigned to Possible Scores)		
		Per cent	Per cent	Per cent
26.	Teacher tries to identify child talents that may lead to new involvements in science for the individual children.	95	100	100
27.	Children are provided with some "free" time to use for their own individual or group science activities.	83	92	100
28.	Materials for quick working experiences are left out for children to examine.	96	98	96
29.	Long-term science activities are opened up to any of the children, individually or in group participation turns.	96	96	96
30.	Teacher tries to rate children on development of new interests, curiosities, attitudes and problem-solving skills.	38	63	75
31.	School-wide science events are available for all children: exhibits, fairs, clubs, hobby shows, assembly programs.	58	75	79
32.	Children are kept informed of district and regional science fairs, open to their participation.	23	47	75
33.	Teachers use children of special experience background as resource persons.	63	88	93
34.	Teacher keep "open-door" policy to be sure of having live animals in class.	83	78	71
35.	Living plant studies are used for experiential purposes in science.	62	84	90
36.	Classroom has movable chairs and desks.	93	88	88
37.	Classroom has work space and science tables available.	100	96	96
38.	Classroom has a water source inside.	88	93	93
39.	Classroom has electrical outlets for convenience of science investigations.	87	92	92
40.	Classroom has a basic supply of science equipment such as: dry cells, wire, magnets, blue print paper, metal sheets, bottles and chemical supplies.	77	87	91
41.	Classroom has a source of open-flame heat for the science investigations.	41	91	95
42.	Classroom has a basic supply of hand tools for wood, paper, metal or plastics.	91	91	95
43.	Classroom has storage facility for science equipment and materials.	93	93	96
44.	Classroom has available audio-visual equipment for science studies.	97	97	100
45.	All teachers may use a petty cash fund for remuneration to the extent of: K–3...\$15, 4–6...\$28, 7–8...\$36.	100	100	100
46.	Refrigerator is available for ice cubes or cold-storage science facilities.	50	55	63
47.	School has a special room outfitted like a miniature laboratory for individual student, or class group, use.	26	36	59
48.	School has a "growing room" or animal room for experiential work in these areas.	37	45	46
49.	School has outdoor facilities like: cold frame, hot-bed, garden, nature trail.	70	78	83
50.	School has exhibit cabinets or a museum for display of science activities.	58	67	71

The 50 check list items represent the basic criteria as follows. *Criterion One: Learning Tools for Science* includes items number 1 through 10, 25, 34, 35, thirteen items in all. For example, item number 2 states: "Use of a science demonstration frequently to introduce here-and-now realism." *Criterion Two: Scientific Attitudes* includes items number 15 through 19, five items in all. For example, number 15 states: "The teacher strives for development of awareness of difference between fact and personal opinions." *Criterion Three: Scientific problem-Solving Skills and Aptitudes* includes items number 19 through 24, five in all. For example, number 24 states:

"Children continuously try to find ways of using experiment-control in their science problems." *Criterion Four: Individual Differences* includes items number 26 through 29, 31 through 33, seven items in all. For example, item number 27 states: "Children are provided with some 'free time' to use for their own individual or group science activities." *Criterion Five: Evaluative Techniques* includes items number 11 through 14, and 30, five in all. For example, number 11 states: "Children and the teacher take frequent evaluative backward looks." *Criterion Six: Facilities and Materials* includes items number 36 through 50, fifteen items in all; these fall into two sub-groups, facilities and materials for the classrooms and facilities and materials for the entire school program. Examples of classroom facilities are given in item number 38: "Classrooms have a water supply in the rooms," and in number 42: "Classrooms have a basic supply of hand tools for wood, paper, metal and plastics." Examples of entire-school facilities are given in items number 46: "A refrigerator is available for ice cube or cold-storage science facilities," and in number 49: "The school has outdoor facilities like: cold frame, hotbed, garden, or nature trail."

The 50 items were selected and modified from an original checklist of 76 items that represented the initial attempt to identify an improvement. Pilot study of the group checklist both by classes of teachers and principals and also with similar people in their schools was chiefly responsible for the elimination and revamp of evaluative ideas. Validation of the items is described below.

VALIDATION OF THE CHECKLIST ITEMS

Two juries of elementary-school science experts gave responses intended to test the communication clarity and the extent of validity of the initially proposed items. Each of the jury actions is represented in turn immediately below.

Validation by the First Jury

The first validation attempt of the checklist items took the form of value judgments solicited from experts in the field. The value scale is shown in the instruction to the nine members of the First Jury.

> Use a three-place value rating scale for each item as follows:
> Use "2" for of *great potential to contribute* to the elementary-school science programs.
> Use "1" for of *moderate or some potential to contribute* to elementary-school science programs.
> Use "0" for of *little or no potential to contribute* to elementary-school science programs.

As has been indicated above, trial runs and pilot study of the initial stages had produced modification and clarification. In the original checklist submitted to the First Jury, and later to the Second Jury, nearly half of the items were accompanied by parenthetical explanations or illustrations.

First Jury responses were generally favorable. One juror questioned the general framework of the study; this resulted in a format change of the items. Another juryman questioned the implied checklist viewpoint; after conference and minor changes, his reservations seemed to have been removed. Two members of the Office of Education checked the items but made no generalized summary remarks. The other five jurors expressed either satisfaction, or enthusiastic approval, of the checklist items.

More specifically, of the 450 checklists (50 each for each of nine jurymen), 19 were marked 0 and 17 items were omitted entirely. The tabulation below shows the average pooled First Jury ratings by major criteria groups:

	Items	Per Cent
Learning Tools for Science	13	91.7
Scientific Attitudes	5	97.7
Problem-Solving Skills and Aptitudes	5	93.0
Individual Differences	7	83.3
Evaluative Techniques	5	85.8
Facilities and Materials		
For Individual Classrooms	9	82.5
For School-Wide Science Activities	6	47.2
All Checklist Items	50	85.1

In this list the average per cent ratings were determined as equal to the ratio of the sum

of the assigned ratings to the highest possible score for each item. Thus, if six of nine jurors rated an item "2" while the other three rated it "1," the sum of the assigned ratings is 15, and since the highest possible score is 18, the ratio of 15/18 is 83.3 per cent.

The average ratings for the scientific attitudes items, the problem-solving skills and aptitudes items and the learning tools for science were considerably above the average for all items. Does the fact that the lowest rated items and category average was for facilities and materials mean that this criterion is less important than the other five?

The tabulation below shows both the 11 items that were assigned unanimous First Jury acceptance and, in addition, the five items which were found least acceptable.

Checklist No.	Classification or Criterion	Average Rating
3	Learning Tool for Science	100
4	Learning Tool for Science	100
5	Learning Tool for Science	100
13	Evaluative Technique	100
14	Evaluative Technique	100
16	Scientific Attitude	100
17	Scientific Attitude	100
21	Problem-Solving Aptitude	100
23	Problem-Solving Aptitude	100
25	Evaluative Technique	100
45	Facilities and Materials	100
12	Evaluative Technique	55
40	Facilities and Materials	57
47	Facilities and Materials	33
48	Facilities and Materials	38
50	Facilities and Materials	50

Since the checklist included 15 facilities and materials items, the unanimous acceptance of but one of these, and the low ratings of four others, italicize the question above about the importance of specific facilities and materials. The experts apparently believe that specific teaching practices related to the learning tools for science, the development of scientific attitudes and problem-solving skills and aptitudes, and evaluative techniques as criteria are more important.

The five lowest rated items (by the First Jury) need comment. Item number 12, rated at 55 per cent, involving the children in an anonymous evaluation of the teacher and her science teaching methods, is a puzzle. Low rated, it implies that children, in whom we hope to develop discriminating ability, are not to be trusted to judge the teacher's personality, practice or methods of science teaching. Item number 40 was ambiguous; its subsequent modification was found highly acceptable by the Second Jury. Items number 47, 48 and 50, concerned with facilities for the whole school, indicate that the experts would place more emphasis on the classroom facilities and materials.

In concluding the work of the First Jury, the fact that they spoke of considerable difficulty in rating certain items because of different developmental understandings and skills of children, pointed to the need for validating each item at each of the three major levels of the elementary school. It appears to be true that the muscular coordination or skills in performing certain manipulations, that the degree of proficiency in the communication arts and that the depth of penetration of the idea of causative mechanisms, do vary significantly for the average primary, intermediate or upper grade child. Therefore, each major level of the elementary school would need separate validation. Thus, the function of the First Jury demonstrated the need for a follow-up study which would attempt to take into consideration the development differences of children of varied age groups.

Validation by the Second Jury

The need for a second round of referral of the checklist to expert judgment developed as certain members of the First Jury found difficulty in assigning values for certain items because the age level of the children would probably make considerable difference.

Seven of the First Jury and eight others, equally well known because of their influence in elementary science, agreed to act as the Second Jury.

Suggestions which had come from the First Jury caused minor change in the content and order of the checklist. The principal function of the Second Jury was that of

validating the items for each of the three major levels of the elementary school. The 2–1–0 value scale was used, rather than a five-point scale, because so little appears to be known about the specifics of grade placement. Thus, the Second Jury function became that of making value judgments of the appropriateness of each checklist item at each of the major levels: K–3, 4–6, 7–8.

Second Jury data, shown at the beginning of this paper, is expressed in per cents which are equal to the ratio of the total assigned score to the possible score. Thus, the 63 per cent, item 33, at the K–3 level, was obtained because the total assigned score of 19 (four jurors rated it "2," for eight points, and 11 jurors rated it "1," for 11 points . . . and 19 total points), is 63 per cent of the highest possible score of 30 (15 judgments of "2" each). A brief study of the per cent values will indicate that the three major level values provided opportunities for discriminating judgments; the values assigned indicate that such judgments were made. Thus three items (numbers 34, 36 and 37) show decreasing values from K–3 through 7–8. Fourteen items show a spread of from five to 12 percentage points. Thirteen items have a spread of from 13 to 40 percentage points and items number 12, 32 and 41 spread out over a range of from 41 to 56 percentage points.

Several of the differentiated values appear to have weights paralleling our concepts of the varying competencies of children with skills of communication and/or of muscular coordination. For example, the 71–79–88 per cent, for ability to "use a variety of written sources of communication," and the 45–91–95 per cent, for readiness of children to "use an open-flame source of heat in science work," both suggest increased aptitude with increasing chronological age level.

A few of the items are found to have puzzling jury ratings. (1) Item number 47: *The school has a special room outfitted like a miniature laboratory available for individual student or class group use.* The 26–36–59 per cent suggest first, that the idea of a laboratory appears to be of little potential at any level, and second, that primary and intermediate grade children would benefit little from laboratory experiences. Knowledge about the developmental aspects of children suggest that pre-adolescent children have more readiness for interest and curiosity development, and are socially less inhibited in the expression of inquisitiveness, than upper grade adolescents. The Stefaniak study produced evidence that laboratory methods are more rewarding both in knowledge achieved and in scientific attitudes developed than non-laboratory methods in middle grades.[1] Generally children have more interest in "experiments" and science demonstrations than in vicarious science; it is assumed that there would be more interest if they were to be able to go into the laboratory for some experiment work at their level. (2) Item number 12: *Children anonymously evaluate their teacher and the learning methods used in studying science.* Five questions were included in the detailed statement of the item, questions like: "Are the science activities used meaningful?" Second Jury ratings of 13–36–43 per cent for the K–3, 4–6, 7–8 levels suggest that the jurors have little faith in the ability of young children especially to make logical decisions of this kind. Is this true? Is this ability to pass sound judgments about one's teacher delayed till sometime after eighth grade, is it not developed before while children are in the elementary school? The fact that the same jurors rated item number 25 *(Children help to determine the purposes and activities of the science program.)* 87–95–96 per cent suggests a basic inconsistency in these jury ratings. Each of these points, (1) and (2) above, need further study to reconcile these puzzliments.

SUMMARY

The work of the pilot study and of the two-step validation process of this checklist

[1] Edward Stefaniak, *A Study of Two Methods of Teaching Science in Grades Four, Five and Six,* unpublished Doctor's thesis, Boston University, 1956.

for the evaluation of elementary-school science resulted in a format and content which, although not perfected, seemed adequate to the purposes and needs of the study. It apparently had the approval of most of the 16 experts who assisted in one or both of the juries. Its items represented selection in terms of criteria basic to both the objectives of elementary education and to the psychology of learning. Its items had assigned values weighted to account for the developmental interests, aptitudes and skills of children at the three major grade level groups, K–3, 4–6, 7–8, in some degree at least.

It then became the guiding checklist used in evaluating the classroom programs of 54 teachers whose "typical" science lesson the investigator observed, and of 172 other teachers in New Jersey who self-administered it in relation to the programs of science which each one had been using. The findings from this study represent the data upon which the investigator's dissertation research is founded.

THE TEACHING OF SCIENCE IN ELEMENTARY SCHOOLS BY RECENT GRADUATES OF ATLANTIC CHRISTIAN COLLEGE AS RELATED TO THEIR SCIENCE PREPARATION * †

JESSE PARKER TYNDALL

Atlantic Christian College, Wilson, North Carolina

THE problem for this study was to investigate and to evaluate the science teaching of recent elementary graduates of Atlantic Christian College and to examine the science program provided at the college for prospective elementary teachers. Specifically, the study was concerned with the following questions.

1. What is the type of science preparation received at Atlantic Christian College? How much science was taken by the teachers and what grades were received in science and in the total college program?
2. What is the status of the science teaching of recent elementary graduates of Atlantic Christian College?
3. Is the science preparation received at Atlantic Christian College adequate for elementary teachers?
4. In what ways may the science program at Atlantic Christian College be improved?

As a springboard for the study, a search was made of related research and literature in order to illustrate the historical progress of science education since its inception in the elementary school curriculum. Further, a study was conducted to locate significant research and literature concerning the preparation of elementary teachers in the field of science. The research and other educational literature point to the need for content and professionalized science courses in the preparation of elementary teachers. It points to a need for the strengthening of college and state science requirements for elementary teachers. It also points to a need for more research in the area of science education, especially from the standpoint of child development.

The next step in the study was to devise means of evaluating science practices of elementary teachers. With this in mind, a checklist of characteristics of a good elementary science program was constructed, covering six categories including sixty-one items. This checklist was submitted to twenty experts for rating. From their ratings eighteen of the sixty-one items were eliminated. Using the items included on the specialist checklist, the following instruments were constructed: an observation checklist, an interview checklist, and a questionnaire.

* Paper presented at the Thirty-second Annual meeting of the National Association for Research in Science Teaching—Council for Elementary Science International, Hotel Dennis, Atlantic City, New Jersey, February 21, 1959.

† Based on author's dissertation for the degree of Doctor of Education, University of Florida, 1956.

During the construction of the checklists, forty recent elementary education graduates of Atlantic Christian College were located and were contacted for permission to be included in the study. All forty teachers agreed to participate.

Two main procedures were followed. One was to scrutinize the high school and college records of the teachers and to determine what science was taken, how much was taken, and the achievement of these teachers in their courses. The second was to observe and evaluate the science teaching being carried on in the classroom of the recent graduates.

The records of the teachers were studied and a compilation of high school and college science courses taken was made. In addition, college science grade-point averages and over-all grade-point averages were recorded. From those compilations it was found that the biological sciences were taken more frequently in both high school and college than were the physical sciences. The compilations of the grade-point averages are discussed in the section of this summary concerned with chi-square.

The checklists constructed were used in different ways. The observation checklist was utilized in making two observations of the science teaching of each teacher. In addition to the observation checklist data, it was established by observation that sciences of a biological science nature were taught more frequently than sciences of a physical science nature. The interview checklist was used at the end of the second observation or on a subsequent visit. The questionnaire was completed by the teachers and mailed to the researcher.

The validity of the three instruments was established by using only those items rated as essential by fifteen of the twenty specialists. The reliability of the observation checklist was established by having another person make observations with the researcher. There was an agreement of eighty-five per cent between the researcher and his colleague. The reliability of the questionnaire and interview checklist was established by using these two instruments one year later with twenty of the teachers chosen at random. There was an eighty-two per cent agreement between the data of the two questionnaires and an eighty-three per cent agreement between the data of the interview items.

If eighty-five per cent of the teachers in the study were meeting a specific criterion on the observation checklist, interview checklist, or questionnaire, the researcher judged that performance on this criterion was satisfactory. Those respects in which teachers met the criteria satisfactorily were found to be as follows:

1. They utilize storage space in an orderly manner.
2. They respect children, give personal attention to, and enjoy working with children.
3. They emphasize facts and principles and are objective in the presentation of materials to their students.
4. Their programs are student-teacher planned and provide time for spontaneous and other experiences in order to develop scientific attitudes and concepts.
5. They encourage use of materials from the students' environment and integrate science with other areas of study.
6. They encourage investigation in solving problems, aid children in arriving at tentative scientific conclusions, and encourage students to relate scientific conclusions.
7. In their evaluative programs they observe children to see if there is any observable change in behavior after studying a particular topic.
8. They make use of science experiments which are not dependent upon expensive equipment, and they use these experiments in answering questions.
9. They hold discussions in connection with multisensory materials and use science books of different topics as reference and reading materials.

The weaknesses in elementary science teaching of the teachers are as follows:

1. The teachers lack an understanding of the importance of a laboratory-like classroom in teaching children science.
2. They do not encourage participation of children in class activities and do not provide an atmosphere of freedom and responsibility in their classrooms to aid children to comprehend democratic ways of working together.
3. They seldom provide a variety of opportunities for developing children's leadership, nor do they provide for experiences that allow for variation in maturity levels.
4. They do not encourage children to see the relationships between the physical and biological

sciences, nor do they help students to understand inclusive scientific principles.

5. They make little use of comprehensive evaluation in their science programs.

6. They seldom use science pamphlets in their teaching.

7. They make very little use of community resources, including resource persons.

After the interview checklist was utilized the teachers were asked five questions which the researcher hoped would be provocative. When the question was asked, "What did you have in your college teaching which helped you in carrying on a science program?" fifteen per cent stated that nothing taken in college helped, whereas eighty-five per cent mentioned courses and topics which aided. Most of the responses were concerned with general biology. When asked what type experiences would have helped in carrying on a science program, the responses dealt with professional content, science content, knowledge of children, methods, and materials.

Question three was concerned with the helpfulness of in-service experience. Over half the group stated they had had no such experiences. Question four was asked in order to determine any other experiences which might have been helpful. Fifteen of the forty stated that they had had no other experiences which aided; the remainder gave an array of responses, frequently a different response for each teacher. Question five (actually a composite of many questions) was asked in an effort to determine the importance of science in the elementary classrooms of the teachers in the study. The teachers' responses indicated that almost all of them felt science to be very important, with but one teacher indicating science to be of no importance for children in primary grades.

Once the type and quantity of preparation received was determined and the status of elementary science in the classroom was established, it was decided to use a statistical method to relate qualities of teaching to strengths and weaknesses in the college science-preparation of elementary teachers. Before summarizing the results of chi-square, the statistical method chosen, it is necessary to make two statements that might influence the significance of chi-square in this particular study. First, the checklists were constructed from one point of view and the college science courses were taught from another point of view. Second, inadequacies indicated by chi-square are not necessarily the sole responsibility of science courses offered elementary teachers.

The results of the chi-square calculated indicate:

1. There was a high degree of relationship between grades made on science courses and performance as elementary classroom teachers in the area of science.

2. The relationship between performance and general grade-point average was a little below the five per cent level of confidence.

3. There was no significant relationship between courses taken and the quality of science teaching.

4. There was no significant relationship between teachers' performances and those that mentioned specific courses as being helpful.

5. There was no significant relationship between teachers with or without in-service experiences and the quality of the science teaching.

6. There was no significant relationship between other experiences mentioned as helpful and the quality of science teaching.

From the data obtained within the limitations of the study, it seems that the following recommendations for the preparation of elementary teachers in science at Atlantic Christian College are warranted:

1. The college program should continue to stress the biological sciences in order to provide prospective elementary teachers with an understanding of the biological world necessary for working effectively with elementary school children.

2. The science program should continue to make use of materials from the environment of prospective teachers in order to encourage the continuation of this practice in elementary classrooms.

3. The science program should continue to encourage students to use the scientific method of problem-solving in order to develop skills and attitudes essential to teaching science to children.

4. Since high school and college records indicated that the teachers have had very little physical science, and since very little physical science was taught by the teachers, it appears that Atlantic Christian College should provide experiences in the physical sciences. This is important because many of the materials and devices of modern civilization are based upon the application of physical sciences.

5. The preparatory work for prospective teach-

ers should be strengthened to include the following in order to prepare teachers to develop adequate science programs in their classrooms:

Aid in the development of ingenuity to manipulate a classroom into a laboratory-like atmosphere.

Preparation which would give insight into the variation in maturity levels of elementary school children.

Broad principles and generalizations, so that teachers can aid their children in understanding scientific principles and the relationships between the physical and biological sciences.

Experiences in the use of comprehensive evaluation.

Preparation providing teachers with information concerning the obtaining and use of pamphlets in their programs.

Experiences which would make students aware of the wealth and accessibility of community resources and resource persons.

Provide more experiences dealing with professional content, science content, methods, and materials.

Provide experiences which would help the teachers to understand elementary school children better.

6. The college should not shift its responsibility for the preparation of elementary teachers in science to in-service experiences and other experiences.

As for possible uses of the recommendations at Atlantic Christian College, it is unlikely that the science program of the college could assume the responsibility for all of the recommendations given; however, it is likely that it might better prepare its teachers in the field of science by instigating a general science course with laboratory experience, carrying six semester hours credit. This course should include experiences in the physical as well as in the biological sciences. Further, this science program might include a professionalized science-methods course with experiments, materials, and methods suitable for use by the teachers in the elementary school.

Problems for future study are as follows:

1. If the recommendations given in this study are accepted at Atlantic Christian College, sometime after the instigation of the program, a study similar to the present one might be conducted to determine the adequacies and inadequacies of the new program. In conducting this research a larger sample should be chosen, more observations should be made, and the present instruments should be revised to fit the new situation.

2. A study could be conducted to determine the extent that the situation at Atlantic Christian College is like that at other institutions.

3. The instruments constructed for this study might be used in evaluating the preparation of teachers of high school science graduating from Atlantic Christian College and other institutions.

CONSIDERATIONS IN SELECTING, DEVELOPING, AND VALIDATING LABORATORY EXPERIENCE UNITS IN GENERAL BIOLOGY FOR PROSPECTIVE ELEMENTARY SCHOOL TEACHERS *

B. John Syrocki

State University College of Education, Brockport, New York

The problem of this study was to develop the considerations and techniques for the selection, development, and validation of laboratory experience units in general biology, a procedure that could be used by college instructors to develop experience units for undergraduate elementary education majors. For purposes of this study, the laboratory experience units were centered about those principles which an elementary school teacher should understand in order to teach about plants and animals.

The definition of a principle of biology developed by Martin[1] was used. An experience unit was considered to consist of

* Paper presented at the Thirty-Second Annual Meeting of the National Association For Research in Science Teaching—Council for Elementary Science International, Hotel Dennis, Atlantic City, New Jersey, February 21, 1959. Based on the author's dissertation for the degree Doctor of Education, North Texas State College, Denton, Texas, 1956.

[1] Edgar Martin, "A Determination of the Principles of the Biological Sciences of Importance for General Education," *Science Education*, 28:152–163, April, 1945.

two or more activities in general biology which centered about a principle of biology for the purpose of developing those meanings which collectively should help students to understand some aspect of a major principle of general biology.

SIGNIFICANCE OF THE STUDY

One important aspect of instruction in biological science at most teacher training institutions is the provision of laboratory experience. Washton [2] reiterated that educators in the field of biology are stressing the teaching of biological principles, or understanding about plants and animals. Haupt [3] pointed out that understandings of scientific principles should be the basic acquisition of pre-service teachers in a broad course in science, so that teachers will have the understandings or means with which to help individuals to interpret their immediate environment. Merrill [4] supported the statements of Greenlee [5] by saying that labortory procedures should be employed which will (a) provide an acquisition of principles of science and the many facts of science, and (b) are of the type which may be applied in some form to the instruction in the elementary schools.

If we are to prepare elementary school teachers to teach about living things, certain acquisitions of understandings of principles of general biology should be assured. One of the media of instruction in effecting understanding concerning living things is the laboratory experience. In selecting and developing experiences for prospective elementary school teachers, problems arise as to how this may be accomplished, and which activities should be selected and/or developed.

PROCEDURE

Major Steps

The procedure for this study consisted of the following six major steps:

1. Formulating a list of principles of general biology.
2. Determining the comparative value of a list of principles of biology for the elementary school teacher, as judged by a jury of elementary school teachers.
3. Formulating a list of criteria for the selection and development of laboratory experience units in general biology for prospective elementary school teachers.
4. Developing laboratory experience units in biology in terms of the criteria selected for this study.
5. Developing a rating scale for the evaluation of the laboratory experience units in biology.
6. Validation of eight laboratory experience units by a jury of college biology teachers.

BRIEF SUMMARY OF PROCEDURES

In order to acquaint the reader quickly with the procedures utilized in this study, a brief summary of procedures is presented.

1. *Principles of General Biology.* A list of principles of general biology was compiled from reports of previous studies and from a survey of elementary science textbooks and college biology textbooks. The list of principles in biological sciences by Martin [6] and Washton [7] were most helpful in setting up a tentative list of principles of general biology. A validated list of 106 principles that was technically accurate and covered the field of general biology, and the rating of these principles by two select groups of elementary school teachers was prepared by Syrocki.[8] This list was com-

[2] Nathan S. Washton, "Teaching Biology for General Education," *Science Education*, 36:227-237, October, 1952.

[3] George W. Haupt, "An Attempt at Specificity in an In-Service Program of Education for Teachers of Science," *Science Education*, 25:142-143, March, 1941.

[4] William E. Merrill, "A Proposal for Science in the Education of Elementary Teachers at Radford College," unpublished doctoral dissertation, Teachers College, Columbia University, New York, 1952.

[5] Julian Greenlee, "Science Experiences in an In-Service Program of Education for Teachers of Science," *Science Education*, 25:143; March 1941.

[6] Martin, *op. cit.*, April, 1945.

[7] Nathan S. Washton, "A Syllabus in Biology for General Education II," *Science Education*, 36:227-237, October, 1952.

[8] B. John Syrocki, "Principles of General Biology for Prospective Elementary School Teachers," *Science Education*, 42:86-93, February, 1958.

piled in the descending order of the importance of these principles for elementary school teachers to understand in order to teach about plants and animals.

2. *Formulating a List of Criteria for Developing Laboratory Experience Units in General Biology.* There was no single list of criteria which suited the purposes of the present development of experience units for prospective elementary school teachers. For this reason, the list of criteria was formulated after a survey of articles in educational journals and discussions in science books and laboratory manuals dealing with activities in biology for college students. Books dealing with methods of science education were most helpful. Some criteria were formulated independently of suggestions in the literature in order to suit the purposes of developing units of experiences for elementary education majors.

3. *Eight Criteria for Developing Laboratory Experience Units in General Biology.* Eight criteria were adopted for the development of experience units, as follows:

(1) The laboratory experience unit should be selected and/or developed in terms of its possible contribution to some aspect of the principle of biology which is very important to know, as judged by two select groups of elementary school teachers.
(2) The laboratory experience should provide for an individual experience.
(3) The procedures for the experience unit should be clear and concise.
(4) The materials and equipment for the experience unit should be available in the college biology room, or easily obtained and/or constructed and accumulated by the student or instructor, or available as a community resource within a reasonable walking distance of the college.
(5) The experience unit should include appended questions which are likely to stimulate reflective thinking.
(6) The experience unit should be of sufficient scope to permit the student to draw conclusions.
(7) The outcomes listed for the experience unit should be expected from student participation in the unit.
(8) The experience unit is consistent with the purpose of a course in general biology for the preparation of elementary school teachers.

4. *Developing Eight Laboratory Experience Units in General Biology.* For purposes of illustration, and because it was not practicable here to use all of the principles considered important, eight labortory experience units corresponding to the eight principles of biology were developed. The eight principles which were selected for development were the ones which were rated as the most important for elementary school teachers to understand in order to teach about living things. Another reason for selecting eight principles for the development of units was that this number would be convenient to a jury in validating the completed experience units.

Each experience unit is to include (a) the principle, (b) title and number of the unit, (c) titles of the activities included in the unit, (d) detailed write-up of each activity, (e) appended questions, and (f) a list of specific understandings or outcomes. Here is a preliminary development of an experience unit:

Principle No. 2: Roots of plants are adapted structurally to absorb water from the soil and transport it to the leaves where it may be used to form food; most of the water evaporates if the leaves are thin.

LABORATORY EXPERIENCE UNIT NO. 2

Absorption and Translocation of Water in Plants

A. Form of Root Hairs
B. How Water Enters Plants
C. Passage of Water Through a Membrane
D. Movement of Soil Water in Hard Stems
E. Water Leaves the Plant
F. Amount of Water Loss from Plants

5. *The Rating Form to Be Used in Evaluating Laboratory Experience Units in General Biology.* The rating form consisted of a list of the eight criteria used as guides in developing the units. Each criterion was numbered, and to the left of each number were the letters "IC," "SC," "PC," and "NC" to constitute the code letters by which the criteria were considered by the jury.

The following explanation for the code was given in the letter of instruction.

IC—This criterion was ideally considered in developing this experience unit in biology.
SC—Criterion was satisfactorily considered.
PC—Criterion was poorly considered.
NC—Criterion was not considered.

6. *Selecting a Jury.* The jury consisted of eight college instructors who teach a biological science which is required of prospective elementary school teachers. The names for this jury were selected from the list of instructors who submitted courses of study in biological science. A letter was sent to a number of college instructors requesting their co-operation. The responsibility of the faculty member as a judge in this study was outlined carefully, and the nature of the scheme of evaluation was explained.

7. *Assigning Values to the Rating Scale.* To determine the average judgment value for each criterion when rated by the jury, the code letters were given the following numerical values: IC = 6, SC = 4, PC = 2, and NC = 0.

8. *Ratings of the Units by Individual Judges.* The ratings given to each of the experience units by the judges were tabulated and average numerical values were determined for each unit as rated by the eight judges.

$$\text{Index of Acceptability} = \frac{\text{Sum total values of the criteria}}{\text{Number of jury members}}$$

Only those experience units rated 4.0 or better are accepted as satisfactory for classroom use. In order for the returns to be of value, in the event a unit scored an *average* judgment value of less than 4.0, judges were instructed to indicate the reason why a laboratory experience unit was given a rating of "PC," or "poorly considered." This is an important consideration since it makes it otherwise difficult to trace a specific deficiency within a large experience unit. Should the unit be rated less than 4.0, it is to be revised in the light of the comments, and returned to all judges for further validation.

SUMMARY AND CONCLUSIONS

Considerations in Formulating Experiences in Biology for Elementary Education Majors

1. To ascertain the technical accuracy of a tentative list of principles of general biology, it was necessary to consider the judgments of other faculty who were acquainted with general biology. It was deemed necessary that these instructors should also be teachers of a course in biological science that is required of elementary education majors.

2. One of the aspects of this study was to develop a list of principles which an elementary school teacher should understand in order to teach about plants and animals. An assumption was made that one of the best sources of opinion would be a select group of good elementary science teachers.

3. To report ratings of principles of biology, indices of importance had to be established. Numerical values were assigned to a three-point scale to compute the *average* judgment value.

4. To determine the consistency of the ratings, it was necessary to estimate the reliability of the scale values. This was accomplished by computing the Pearson's coefficient of reliability.

5. To select and/or develop laboratory experience units, some criteria or guides were needed by which such development or selection would be uniform and helpful from one unit to another.

6. For convenience of validation of the experiences by a jury, the number of units had to be kept to a minimum. Eight principles and their units consisted of thirty-five individual activities and covered forty pages of writing. This amount of material for validation should be considered maximum.

7. The final step in the development and acceptance of the units consisted of sending the units to a jury of college instructors of biological science. Prior to asking instructors to serve as judges, a selection of

potential judges was made on the basis that this instructor considered and utilized the activity-method of approach to teaching general biology. This was expedited by checking the nature of the course of study in general biology which was submitted for the purposes of this study.

8. To evaluate the developments of units, a four-point rating scale was developed to indicate the extent to which the eight criteria were considered in developing the units.

CONCLUSIONS

1. A technique was developed, which by example, was instrumental in satisfactorily guiding the development and validation of laboratory experience units in general biology for elementary education majors.

2. There was strong agreement among a select jury of elementary school teachers as to the importance of understanding certain principles of biology in order to teach about plants and animals. The high degree of consistency of the ratings may have been the result of careful selection of elementary science teachers to a jury. The methods of selection that proved useful are: (1) Recommendation of elementary school teachers by leaders in the field of elementary science education, and (2) Evidence of a strong interest in elementary science by having published articles in periodicals and/or magazines.

3. Indices of importance were most useful in ranking principles of biology, and deciding as to the acceptability of a laboratory experience unit in biology.

4. Five college instructors is an adequate number of judges to validate units in biology.

5. The eight criteria for the validation of the experience units were sufficiently clear and concise to enable the jury to proceed with the validation of the units.

A WORKSHOP: SCIENCE ACTIVITIES FOR CHILDREN

DR. B. JOHN SYROCKI
State University College of Education, Brockport, New York

FIFTY-FIVE in-service teachers attended a two-week science workshop at the State University College of Education at Brockport, New York during the summer session from August 12–23, 1957. This course was offered for two semester hours of credit. It is the intent of this report to share with you some of our experiences in organizing and conducting a workshop for a large group.

PURPOSE

The purpose of the workshop was twofold: (1) To enable in-service teachers to participate in planned science activities for children under the supervision and organization of a consultant, and (2) To offer the necessary opportunities in service and materials to enable students to develop a group of related activities for their classroom use.

ORGANIZATION

Workshop Staff. Participating as full-time consultants were professor Frank Harman of Buffalo State Teachers College, professor Russell Wallin, and Director B. John Syrocki of Brockport. Part-time consultants included Robert Brandaur, Herbert Bailey, and Principal Herman Lybarger of the Campus School at Brockport.

Course Requirements. The requirements of this course included attendance and participation in 17 instructional activity periods; preparation of a written science unit for a particular grade level, a project to in-

clude a minimum of ten activities; and a display of ten activities included in the written science unit, to be exhibited during the last day of the workshop.

The Activities Laboratory. After selecting a project, each student was assigned to a consultant. Students reported to the activities laboratory to which they were assigned, whenever time was provided in the daily program. The consultant in charge worked with his group of students, and evaluated the written work and activities completed under his supervision. Three such laboratories were maintained. Materials needed for the development of activities for the exhibit were procured for students. One hundred dollars was set aside for materials and minor services.

The Instructional Period. Each student was given a copy of the program for the following day. Usually students were required to attend two instructional periods during each day which began at 8:30 A.M. and ended at 2:30 P.M. For each period there was a choice of attending one of two more topics. Students were asked to sign up for the different topics; the same sheets would then be used to check student attendance. Seventeen periods of instruction in activities pertaining to special topics were offered during the workshop; 17 topics were in biological science, 30 topics in physical sciences. There was at least one topic in biological science and one or more topics in physical science for each instructional period.

Panel Discussions. In addition to instructional and activities periods, five panel discussions were organized. For each of the five topics, two panel groups of five students per panel were formed for each topic, making a total of ten groups. This permitted participation in panel discussions by fifty students, and group leadership by five students.

THE WORKSHOP DAILY PROGRAM

MONDAY, AUGUST 12TH

8:00 A.M. Registration

10:00 A.M. General meeting in Room ——
Meeting the workshop consultants
Program for the science workshop
Selecting an afternoon instructional period

10:30 A.M. Forming a luncheon and transportation committee for a field study (West Woods, Hamlin Beach, Wednesday, August 14th)
Consultant Luncheon Committee meet in Room ——
Consultant Transportation Committee meet in Room ——

10:45 A.M. Coffee break

11:00 A.M. General meeting in Room ——
Kodachrome slide showing: "Previous Displays of Science Projects" (Slides taken of exhibits of a workshop conducted during 1952)

12:00 *Helping you to select a project.* The consultants listed below will help you to select a science project. You decide whether you wish to develop a science unit in physical or biological science, then report to one of the following rooms for further instruction:
Consultant "Biological Science" meet in Room ——
Consultant "Physical Science" meet in Room ——

12:30 P.M. Lunch

1:30 P.M. *Instructional Period* (select the topic you wish to attend)
Consultant "Classroom Techniques in Meteorology": Temperature and Moisture, and Weather in Room ——
Consultant "Science Activities With Magnets" in Room ——
Consultant "Aquaria for Native and Tropical Fish" in Room ——

TUESDAY, AUGUST 13TH

8:30 A.M. Selection of projects (continued)
Consultant "Physical Science" in Room ——
Consultant "Biological Science" in Room ——
Consultant Project area undecided in Room ——

9:30 A.M. *Group meeting in Room* ——. Planning panel discussions on the following topics:
1. "Audio-Visual Instructional Activities"
2. "Adaptation of Teaching Techniques to Large Groups"

3. "Evaluation of Teaching and Learning in Science"
4. "Library Facilities and Science Education"
5. "Community Resources in Science Education"

10:15 A.M. Coffee break

10:30 A.M. *Group meeting in Room ——*
Final decision on individual projects
Format of the science unit
Report of the field study committee

11:30 A.M. *Instructional period*
Consultant "Making and Reading a Compass" in Room ——
Consultant "Making an Insect Collection" in Room ——

12:30 P.M. Lunch

1:30 P.M. *Instructional period*
Consultant "Constructing and Using Electromagnets" in Room ——
Consultant "Terraria: Building, Maintenance, Types" in Room ——
Consultant "Cold and Warm Fronts in Weather Forecasting" in Room ——

Wednesday, August 14th

9:00 A.M. General meeting at designated place (West Woods, Hamlin Beach)

9:15 A.M. *Instructional period:* Field study
Consultant "Conservation"
Consultant "Pond Life"
Consultant "Landscapes and Simple Photography"

10:45 A.M. Panel discussion: "Community Resources in Science Education"
Panel A: Consultant A
Panel B: Consultant B

12:30 P.M. Lunch

1:30 P.M. *Instructional period*
Consultant "Identification of Evergreens and Broad Leaf Trees"
Consultant "Solar System": field activities
Consultant "Winds, Clouds, Fog"

Thursday, August 15th

8:30 A.M. Panel discussion: "Audio-Visual Instructional Activities"
Panel A: Consultant A in Room ——
Panel B: Consultant B in Room ——

9:30 A.M. *Individual project:* Report to assigned activities laboratory
Activities Laboratory #1 in Room ——
Activities Laboratory #2 in Room ——
Activities Laboratory #3 in Room ——

10:00 A.M. Coffee break

10:15 A.M. Individual project—Laboratory

11:30 A.M. Instructional period
Consultant "Making and Using a Plant Press" in Room ——
Consultant "Flowering Shrubs and Cultivated Flowers" in Room ——
Consultant "Conductors and Non-Conductors of Electricity" in Room ——

12:30 P.M. Lunch

1:30 P.M. Instructional period
Consultant "Simple Electrical Circuits" in Room ——
Consultant "Simple Machines: Levers" in Room ——
Consultant "Human Inherited Traits" in Room ——

Friday, August 16th

8:30 A.M. Panel discussion: "Audio-Visual Instructional Activities"—Continued
Panel A: Consultant A in Room ——
Panel B: Consultant C in Room ——

9:30 A.M. Group meeting in Room ——
Speaker: "Radioactivity and Radioactive Fall-Out" (Demonstration materials from General Electric Company)

10:30 A.M. Coffee break

10:45 A.M. *Individual project*
Activities Laboratory (report as assigned)

12:30 P.M. Lunch

1:30 P.M. *Consultant* "Household Chemistry: From Liquid to Solid" in Room ——
Consultant "The Human Digestive Tract" in Room ——
Consultant "Simple Machines: Pulleys" in Room ——

MONDAY, AUGUST 19TH

8:30 A.M. Panel discussion: "Evaluation of Teaching and Learning in Science"
Panel A: Consultant B in Room ——
Panel B: Consultant D in Room ——

9:30 A.M. General meeting in Room ——
Speaker: "Biological Principles in Science Teaching" [Principles of General Biology which elementary school teachers should understand in order to teach about plants and animals . . . so states a selected group of 56 expert elementary science teachers.]

10:15 A.M. Coffee break

10:30 A.M. Individual project: Activities laboratory

12:30 P.M. Lunch

1:30 P.M. Instructional period
Consultant "Simple Machines: Inclined Plane, Hydraulic Presses" in Room ——
Consultant "Hard and Soft Water" in Room ——
Consultant "Corals and Mollusks" in Room ——

TUESDAY, AUGUST 20TH

8:30 A.M. Instructional period
Consultant "What Is Sound and How Does It Travel" in Room ——
Consultant "Stars and Constellations" in Room ——
Consultant "Clouds and Weather" in Room ——
Consultant "Your Blood Type and Its Inheritance" in Room ——

9:30 A.M. Panel discussion: "Adaptation of Teaching Techniques to Large Groups"
Panel A: Consultant B in Room ——
Panel B: Consultant A in Room ——

10:30 A.M. Coffee break

10:45 A.M. Individual project—Activities laboratory

12:30 P.M. Lunch

1:30 P.M. Instructional period
Consultant "Solar. System: Classroom Activities" in Room ——
Consultant "Controlling Sound" in Room ——
Consultant "Reproduction in Mammals" in Room ——

THURSDAY, AUGUST 22ND

8:30 A.M. Instructional period
Consultant "Speed of Light and Sound" in Room ——
Consultant "Lenses: Demonstration" in Room ——
Consultant "Social Insects" in Room ——

9:30 A.M. *General meeting in Room ——*
Written science units to be collected.
Assignment of tables for the displays of activities on Friday.
Criteria for the evaluation of student displays.
Time reservation for the presentation of activities on August 23rd, for those students requiring time to explain some of their activities on display.

10:00 A.M. Coffee break

10:15 A.M. Individual project—Activities laboratory

12:30 P.M. Lunch

1:30 P.M. Instructional period
Consultant "Forecasting From Weather Maps" in Room ——
Consultant "Heredity and Atomic Radiation" in Room ——
Consultant "Using Light We Cannot See" in Room ——
Consultant "How Heat Travels From One Place to Another" in Room ——

FRIDAY, AUGUST 23RD

8:30 A.M. Setting up the displays of classroom activities

9:30 A.M. Displays ready for observation

10:00 A.M. *Presentation of Activities*
Demonstrations to proceed according to a schedule of time, not to exceed 10 minutes [14 students requested time to explain their display]

12:00 Lunch

1:00 P.M. Evaluation of student displays by consultants

2:00 P.M. Close workshop.

TOPICS AND SUBTOPICS FOR PANEL DISCUSSIONS

"Community Resources in Science Education"

1. Criteria for Selecting Community Resources
2. Use of Community Resources in Science Education
3. Kinds of Community Resources
4. Planning for the Use of Community Resources
5. Integrating Community Resources with the Curriculum

"Audio-Visual Aids to Science Teaching"

1. Advantages of Audio-Visual Materials in Science Teaching
2. Non-Projected Materials in Science Education
3. Evaluating Audio-Visual Aids for Use in Science Education
4. Sources of Audio-Visual Aids
5. Teacher and Pupil-Made Audio-Visual Aids

"Evaluation of Teaching and Learning in Science"

1. What Should be Evaluated?
2. Guiding Principles in the Process of Evaluation
3. Major Steps in Evaluation
4. Evaluation of the Teaching Environment
5. Evaluation of Instruction (Measurement)

"Adaptation of Teaching Techniques to Large Groups"

1. General Problems in Facing Large Groups
2. Adaptation of Pupil-Teacher Discussion Techniques
3. Adaptation of Experimentation and Demonstration Techniques
4. Evaluation Techniques with Large Groups
5. Individual Differences—Provision in Large Groups

"Library Facilities and Science Education"

1. The Community Library
2. Reference Resources in a School Library
3. Types of Library Materials for Science
4. The Classroom Library
5. Correlating Classroom Study with Library Use

SOME TITLES OF INDIVIDUAL PROJECTS

"Rocks: Making and Using Rocks"
"Chemical Changes in Everyday Life"
"The Story of a Seed"
"Plant Reproduction and Seed Dispersal"
"Atoms and Atomic Energy"
"Study of Insects"
"Soil and Soil Erosion"
"Trees and Tree Growth"
"Nature Museum"
"Simple Machines: Lifting Things"
"Life in the Woods"
"Nature Collections for Small Fry"
"Sound: Activities for Children"
"How Gravity Is Useful to Us"
"Sound: How It Is Made and Distributed"
"Plant Relations: Terrarium Displays"
"Making a Weather Station"
"Uses of Electrical Circuits"
"Use and Control of Fire"
"Night Sky and the Solar System"
"Natural Environments in the Classroom"

WHAT INSTRUCTIONAL PERIODS DID STUDENTS ATTEND?

1. Students who elected projects in the biological sciences tended to attend those instructional periods dealing with biology; on the average, topics dealing with biological science were selected 11 times, whereas topics in physical science were selected 6 times.

2. Students who elected projects in physical science, tended to attend those instructional periods dealing principally with physical science. Out of 17 periods, those periods dealing with physical science were selected 11 times. Thirty-two students out of 55

elected to develop science units and activities in the field of physical science. Twenty-three students elected to conduct projects in the biological sciences.

3. What was the attendance at the different instructional periods? Some topics were attended by more students than others. The following is a table to show the extent of attendance at the 47 different instructional periods:

TABLE I

SELECTION OF CERTAIN TOPICS DURING INSTRUCTIONAL PERIODS, IN THE DESCENDING ORDER OF THE NUMBER OF STUDENTS ATTENDING

Number Attending	Topic
33	Household Chemistry: Liquid to Solid
31	Hard and Soft Water
27	Social Insects
26	Terraria: Building, Maintenance, and Types
26	Pond Life
26	New Antibiotics
24	Light: The World in Color
23	Heredity and Atomic Radiation
23	Experiences with Rocks
22	Solar System: Classroom Activities
22	Winds, Clouds, Fog
22	Identification: Evergreens and Broad Leaf Trees
21	Human Inherited Traits
21	Flowering Shrubs and Cultivated Flowers
21	Cold and Warm Fronts in Weather Forecasting
21	Temperature, Moisture, and Weather
20	Forecasting from Weather Maps
20	Corals and Mollusks
20	Reproduction in Mammals
19	Making and Using a Plant Press
18	Lenses: Demonstration
18	Taking Care of Small Animals in the Classroom
18	Your Blood Type and Its Inheritance
18	Aquaria for Native and Tropical Fish
17	Stars and Constellations
17	Simple Electrical Circuits
17	Landscapes and Simple Photography
17	Making an Insect Collection
17	Making and Reading a Compass
16	Simple Machines: Levers
15	Science Activities with Magnets
15	Controlling Sound
14	Conductors and Non-Conductors of Electricity
13	What is Sound and How Does it Travel
13	Simple Machines: Pulleys
13	Simple Machines: Inclined Plane
13	Soil Conservation Activities
12	Using Light We Cannot See
12	Speed of Light and Sound
12	What Simple Lenses Do for Us
12	Clouds and Weather Symbols
10	The Human Digestive Tract
10	Solar System: Field Activities
8	Basic Elements of Photography
8	Constructing and Using Electromagnets
5	Heat and Expansion
3	How Heat Travels from One Place to Another

HAWAIIAN SUMMER WORKSHOP IN THE TEACHING OF SCIENCE

JEWELL GARNER *

University Elementary School, University of Hawaii, Honolulu, Hawaii

MUCH has been said about Hawaii's rich mingling of cultures, and the warm friendliness of her people—one might almost call the islands a workshop in human relations. The spirit of "aloha," of which islanders are justly proud, set the whole tone of our science workshop, conducted at the University of Hawaii in the summer of 1959, where men and women from every racial group in Hawaii, Mainland coeds and veteran teachers, and one young lady from the Philippines, met and worked and played together. Teachers from every level from kindergarten through high school were represented, as well as principals, supervisors, public and private school teachers, specialists of various kinds and one registered

* Jewell Garner, a student in the workshop, is a teacher in the University Elementary School, University of Hawaii.

nurse. The skills and interests of these fifty-three people were innumerable; it seemed there was nothing we needed to work with that some member of the class couldn't produce! We were also fortunate to have individuals in the group who had special "connections" with various industries, community institutions, and government services, which were of invaluable help to us. And, for a visiting professor to lead our workshop, we had Julius Schwartz, "borrowed" for the summer from the Curriculum Bureau of the New York City Schools and the faculty of the Bank Street College of Education.

Our first day was spent in getting acquainted and investigating the resources within the group. A questionnaire was filled out by each person, in which he listed his science background, teaching field, hobbies, and personal expectations from the workshop experiences. Many special talents and interests were revealed, and we found people pursuing various hobbies including the culture of orchids and miniature trees, rock and shell collecting, photography, taxidermy, plant grafting, corsage making, and skin-diving.

The answers on the questionnaire indicated that most people were interested in developing materials in science for use in their own classrooms, and in enriching their background in both subject matter and teaching methods. Local teachers were also interested in working with Teruo Masatsuga, Science Consultant for the Department of Public Instruction in Hawaii, who participated actively in the Workshop, in developing curriculum materials for the new science guide being prepared for the elementary schools of Hawaii.

It was decided that the elementary teachers would concentrate their study on seven basic content areas in science: Magnetism and Electricity, Living Things, Weather and Climate, Communication, Transportation, Earth and Space, and The Earth and Its Resources. Each of these themes was to be developed by a committee made up, as far as possible, of teachers from various grade levels. The intermediate school (junior high school) and the senior high school teachers also formed committees to develop curriculum guides for use at their levels. In addition to these science content committees several "service" groups were organized; an "Aloha" committee to serve mid-morning coffee, an excursion committee to plan field trips, a committee to take care of supplies, and a library committee to organize and circulate the large collection of children's science books which was set up in our classroom.

One of the things that contributed to the success of the workshop was the ideal physical environment we had. We met in two large science rooms in the new University High School. These were airy, ground-floor rooms containing sinks, cabinets, bookshelves, bulletin boards, and tables for work and demonstration. The classrooms opened onto spacious lawns so that we could work out of doors if we wished. We were free to stay from 8 A.M. until as late as we liked. Many people brought their lunches and stayed all day, although the required hours were only from 7:45 to 10:00 A.M.

Mr. Schwartz had suggested that what he expected of us most of all was to "enrich ourselves." I am sure all of us would agree that certain experiences contributed greatly to that enrichment. One of the most valuable of these was the opportunity to borrow and read from a carefully selected library of more than two hundred of the best science books for children (listed and annotated in the bibliography, "Growing up with Science Books," published by *The Library Journal*) which Mr. Schwartz brought with him from the Mainland. These trade books filled in, for many of us, the missing links in our own science background and education. We found in them many exciting teaching ideas to carry back to our classrooms and much that was helpful in the curriculum designing activities we were engaged in. In using these books teachers also discovered approaches to individual children, because

these were books that could be used by children for their own exploration, working at their own pace.

It would be hard to over-estimate the advantages of having a selected library "built into" a workshop classroom, since it would be difficult, in terms of time, to become familiar with these books in any other way. In addition, we had the opportunity of viewing and evaluating filmstrips, films, and science kits.

A second invaluable enrichment experience was the opportunity to go on many well-conducted field trips. These, and the discussions and classroom work which preceded and followed them, helped us design a science curriculum which was related to *our* environment—to the volcanic mountains, the trade winds, to the pineapple and sugar industries, to our geographic position in the mid-Pacific, to the transportation and communication links to the Mainland, and to the stars over Hawaii.

One of the early trips was to the Halawa Pumping Station where class members were able to ride down on a cable car into a tunnel some 240 feet under the ground, and actually see the water table and realize that this was the surface of the under-mountain water supply for the island of Oahu.

The geology trip was another memorable experience. A geologist from the University conducted a bus tour over the southern part of Oahu, pointing out evidence of the island's volcanic origin and changes that have occurred since.

The trip to one of Oahu's sugar mills was most enlightening, especially for our Mainland visitors; here we saw all the steps in the transformation of sugar cane into raw sugar. We followed this up by experimenting with a classroom technique for extracting sugar from the cane. Our experiment was so successful that we ate it up!

A visit to the Punahou Observatory gave many of us our first opportunity to look at stars through large telescopes. It was a real thrill to see Jupiter and four of its moons, Venus as a crescent, and Saturn with its rings. When we set up our own observatory on campus several nights later with several borrowed telescopes it was gratifying to see whole families appear and even some of the people we had contacted as resource persons in other areas!

Many committees made trips of special interest to their particular group. Some of these were to the Hawaiian Electric Company, The Agricultural Experiment station on campus, Foster Gardens, the Weather Bureau, and the Airport. One of the groups was able to go to Makapuu Observatory, where solar flares and solar radio noise are being studied.

We received much inspiration and guidance from several experts in various fields who served as resource people. Not only were these men willing to come and talk to us, but we were able to talk to them directly and ask questions. We extend our thanks to Mr. Edwin H. Bryan, Astronomer and Curator of Collections at the Bishop Museum, who helped us become acquainted with stars over Hawaii; to Mr. Saul Price, Research Meteorologist at the U. S. Weather Bureau and to his staff, who gave us invaluable aid in our study of Hawaiian weather; to Dr. Agatin Abbott, Professor of Geology, University of Hawaii, who conducted our geology tour; to Dr. Richard Ho, Physician at Children's Hospital, who talked to us about poisonous plants in Hawaii—a subject important enough in the islands to be included as part of the curriculum; to Captain John D. Colbrunn, Public Information Officer, Hickam Air Force Base, who let us in on the most recent activities of our government in the conquest of space; to Mr. Colbert Rousch, Federal Aeronautics Administration, who helped us understand the mysteries of flight, and to Dr. Iwao Miyake, Professor of Physics at the University of Hawaii, who explained the activities at Makapuu Observatory. The materials and the help given us by Teruo Masatsuga reflected not only his personal warmth and enthusiasm, but also

his and the Department of Public Instructions' desire that other teachers in Hawaii should share our experiences and use our findings in developing a science curriculum. Because of this our workshop was able to have an uncommon sense of dedication and purpose.

Although not a part of our course, many class members were privileged to hear evening lectures on campus, by leading authorities in their fields. Some of these were:

Wernher von Braun, Director, Development Operation Division, Army Ballistic Missile Agency, "Count Down for Peace."
Hu Shih, President, Academia Sinica, Taipeh, Taiwan, "John Dewey in China."
C. Landon White, head of Department of Geography, Stanford University, "Population Bomb."

I have mentioned the resource people, the books, and the field trips which contributed to what we feel was a most successful workshop; two other vitally important contributing factors remain. One of these was the inspiration we received from our instructor—the other, the special cross enrichment the members themselves brought to the group.

Mr. Schwartz's sincere interest and evident pleasure in our islands and in us was a constant source of stimulation. His intense curiosity about everything from lizard eggs to why clouds formed continually over our mountains kept us scurrying for answers. He opened our eyes to many things we had looked at but really never seen.

Because he gave so much, individual class members also gave—their talent, their time, and their own materials and equipment. They brought in tools, a tape recorder, movie projector, typewriters, and a duplicating machine. They spent hours of their own time planning field trips, gathering plants, duplicating written materials, and finding free materials and pamphlets for our use. Some of the female members especially, had most persuading ways and seemed able to get almost anything they went after!

Each person kept a kind of personal diary during the course, in which a record was kept of individual interest pursued, as well as group and class activities. (The day by day record of class activities is given at the end of this report.) Each committee gave an oral presentation to the class during the last two weeks, illuminated with experiments and demonstrations. A written report of the work of each committee was made and duplicated so that each class member had a copy. It was good to have this finished, and we were proud of our 300 page "tome," but it also meant that our workshop was coming to an end.

The last class period was set aside for an "Aloha" party. Since we met at 7:45 in the morning, it was decided that we would all have breakfast together. Several people brought electric frying pans for cooking, and imagine our chagrin when our science class overloaded the circuit, and blew a fuse! Breakfast was a little late, but highly successful. It was followed by group singing and a few special dances, and then came the "Hookupu," or bringing of gifts. A large koa bowl was placed beside "our chief" and class members filed by putting individual gifts in it—macadamia nuts, coconut, pineapples, mango chutney, guava jelly, and various other island products. The ancient Hawaiians wrapped their gifts in ti-leaves—we substituted paper, but the feeling was the same—one of "Mahalo" (thank you) and "Aloha."

MAJOR CLASS ACTIVITIES

June 23—Orientation and getting acquainted

June 24—Lecture and discussion of Science in the Elementary School
Plans for field trips to be taken
Setting up of class library

June 25—Lecture and discussion on Electricity and Magnetism
Individual work with dry cells, magnets and compasses

June 26—Continued discussion and work with electricity
Organization of class committees

June 29—Continued work with electricity; made motors

June 30—Prepared questions for trip to Halawa Pumping Station
Saw and evaluated film, "Pipes in the House" (Churchill-Wexler)

July 1—Trip to Halawa Pumping Station

July 2—Evaluation and discussion of field trip
Evening session at Punahou Observatory

July 3—Lecture and discussion on Earth in Space
Outdoor demonstrations of movements of planets

July 6—Lecture and discussion on moon

July 7—Trip to Waipahu Sugar Mill

July 8—Lecture on Solar Energy
Committee demonstrated classroom method for extracting sugar from cane

July 9—Lecture on Space and Space Travel
Work with magnifying glasses and microscopes on local plant and animal specimens

July 10—Demonstration of use of microprojector
Work with plants and animals

July 13—Lecture and discussion on Living Things
Film, "Living and Growing"
Group tour of Agricultural Experiment Station at University of Hawaii

July 14—Prepared questions for geology trip
Went on geology tour in the afternoon

July 15—Lecture by Dr. Abbott, follow-up on geology trip
Experiments with papyrus, rubber, cement, etc.
Group tour of Hawaiian Electric Company

July 16—Lecture and discussion on Earth and Its Resources
Film showing 1955 volcanic eruption on Hawaii
Group excursion to Makapuu Observatory
Evening meeting to observe stars

July 17—Lecture on Solar Activity
Group trip to Foster Gardens

July 20—Presentation by committee on Weather
Lecture by Mr. Saul Price of U. S. Weather Bureau
Group trip to weather station at Airport

July 21—Evaluation of Weather committee report
Presentation by committee on Electricity and Magnetism
Group tour of Honolulu International Airport

July 22—Evaluation of Electricity and Magnetism committee report
Lecture on Aviation by Mr. Colbert Rousch of the Federal Aeronautics Commission
Nature study tour of campus
Evening meeting to observe stars

July 23—Presentation by Committee on Living Things
Lecture by Dr. Richard Ho on poisonous plants
Movie, "Unchained Goddess"

July 24—Presentation by committee on Transportation

July 25—Presentation by committee on Earth in Space
Lecture by Capt. Colbrunn on Conquest Space

July 28—Holiday (Elections)

July 29—Presentation by committee on Communication

July 30—Presentation by committee on Earth and Its Resources
Trip to the quarry

July 31—Aloha party

A SUMMER SCIENCE CAMP *

LINCOLN PETTIT

Department of Natural Science, Michigan State University, East Lansing, Michigan

THE question about the wisdom of closing the public schools for three months during the summer, which was of speculative interest in early 1956 [1, 2], has not been seriously revived despite the competition posed by the presumed efficiency of the educational pattern in the Soviet Union [3].

It is true that many parents and educators believe that vacation time, with all its advantages of healthful, outdoor recreation and family trips and its summer employment for older children, extends beyond the length needed to enjoy the benefits of change. But aside from voluntary attendance in a few schools which provide a scattering of summer courses, there is little to suggest that a grassroots demand for wider summer educational opportunities is in the making.

Those parents who regard the growing volume of knowledge with foreboding, par-

* Departmental contribution No. 140.

ticularly knowledge in the rapidly expanding fields embraced by natural science, will find in the idea of the summer science camp a possible recourse. Since the idea of such a camp has not been explored extensively, a description of a camp which has been operated successfully for two summers should be useful for anyone who might adapt a suitable locality in their state for this purpose.

Dr. George W. Angell, President of the New York State University College of Education at Plattsburgh, conceived a way to satisfy both the recreational and academic needs of promising, scientifically-oriented children, by making use of a tract of land forty miles south of Plattsburgh, New York, in the foothills of the Adirondack Mountains. Here a group of faculty members and administrative officers and college students had established a center for outings and field study, used during the regular school year. Known as the Benevolent and Educational Association, the group had already constructed a lodge and a laboratory. With some modifications and improvement of the facilities, a camp was opened in July, 1958, to accommodate seventeen campers and a staff of seven.

The preliminary effort was so successful that an additional laboratory was built. In 1959 there were thirty-one campers (seven from the previous year) and a staff of twelve, using the site as a base for numerous trips and as a field laboratory for six weeks. The writer was invited to be associate director for 1959. There is the prospect of expanding the camp further for 1960.

The success of the camp prompts me to offer observations for the use of similar educational groups elsewhere.

PHYSICAL FACILITIES

The camp is situated six to ten miles from the nearest towns. The cleared land on which the camp is located was once a farm. There are over 700 acres. The ruins of the buildings were removed and a pond was formed by an earth dam across a small brook. The lodge contains an all-purpose dining area adjoining the kitchen. Upstairs is a space for sixteen persons, dormitory style; this was used by the younger boys, ages eleven to thirteen. Downstairs a smaller dormitory for all the girls and women could accommodate a dozen persons. The older boys and male staff members occupied four-man tents and tipis scattered around the one-acre pond. The younger staff men took turns as residents with the younger boys.

A few rods from the lodge was the laboratory area with its two parts joined by a breezeway. Each laboratory had ample space for sixteen persons at the long counters. Each place was equipped with a lamp, a microscope and a seat. On center tables and adjacent to the sink in each laboratory were various items of equipment for special work—rock trimmer, grinding wheel, chemicals, and so forth. A corner room in each building served as stockroom and office space. In all, there were about 1200 square feet of floor space, exclusive of the two small rooms. On the breezeway were a dozen or more home-made and standard cages for live animals.

A large bus was on call for the thirteen trips taken during the six weeks.

The College at Plattsburgh was the base for equipment and supplies and food. Many truckloads of laboratory supplies were brought from Plattsburgh before camp opened. Tentage, sleeping equipment (including overnight equipment), and kitchen impedimenta were kept at the camp the year around, but all the scientific supplies, maps, motion picture projector and science films, as well as the general and special libraries were brought for the summer.

STAFF

A staff of twelve may seem large for a camp serving only thirty-one children. However, the continuous camp activities ran from morning until night, and lively children of the ages accepted—from eleven to fifteen, inclusive—require much attention.

The older campers were not expected to assume any supervisory duties unless they wished to.

At Plattsburgh, the business manager took care of all financial and supply matters and correspondence. At the camp, the director, Dr. Phillip Walker, and the writer, both experienced in field work and camping, took care of all instructional matters, housekeeping, acquiring supplies at Plattsburgh and elsewhere, supervision of staff personnel, and most extra-academic activities. The next senior staff member, Mr. Michael Ozol, who had had several years' teaching experience, devoted his time to teaching geology and helping campers with special projects. Two recent graduates from Plattsburgh's College of Education who majored in science education assisted with the above-mentioned camp management and teaching and helped with projects and field trips.

The geologist's wife and the nurse spent their time with the girls other than at class time, and also took care of the store, laundry records, occasional recreational evenings and the informal waterfront activities.

The cook was a specialist who prepared the meals from supplies brought from the College Stores Department. She had two helpers. Finally, there was a high school boy, very resourceful, who helped supervise the younger boys and lent a hand with the housekeeping and numerous chores.

Despite the high ratio of staff to campers, we felt we needed additional people to instruct and to care for housekeeping. With two more staff members, a further increase in campers would not be difficult to handle. In fact, time off was a rather serious problem because the campers were never channeled so that only a few persons could direct them. The informal conduct of studies called for someone to be on hand at the laboratories at almost all waking hours.

PROGRAM

The broad plan was to provide general introductions to a variety of sciences the first half of the period, and to specialize in a few—those where sufficient interest was shown—during the second half, with "projects" elected by each camper. The level of instruction was that of college freshman courses or above. Nature study as such was minimized, but we followed a program of associating field observations with laboratory studies and lectures on appropriate principles. For example, everyone developed a passing acquaintance with botany, zoology, geology, astronomy and conservation, and this was followed by restricted work in taxonomic principles in botany, entomology and mammalogy and minerology, because a majority of campers showed interests in these specializations, a few electing one of these for their concentration. In addition, several elected some other field of interest, such as paper chromatography, the solar system, the food of a porcupine, or constructing amplifiers. The wide range of interests taxed the staff beyond its capacity to be expert in all the chosen specialties; it is obvious that a talented pupil might delve much farther into a specialty (paper chromatography, for example) than any member of the staff. We had access to such specialists at the College, but only as a courtesy for a short time.

In the first half of the camping period a dozen or so field trips took the group to several kinds of ecosystems, to collecting places for fossils and representative plants and animals, to geological points of interest and to such diverse places as a fish hatchery and the St. Lawrence Seaway. In addition we had short hikes, a compass course, and practice hikes and overnighters, leading ultimately to a four-day hike in the mountains. The trips combined science education, recreation, and exercise.

Evenings were spent ordinarily in or near the lodge. Nearly fifty science films were shown; the attendance was voluntary, but almost everyone showed keen interest in the films, whatever the subject. Several visiting speakers described their special field of interest. On four Sundays, the entire

group—with a few exceptions—attended concerts at a nearby music camp. On cloudless nights the three telescopes were set up for viewing planets and the moon.

Recreation of a formal nature was not stressed. The campers seemed to be too sophisticated for some of the traditional "skit night" routines which are part of nearly all camps. Some of them expressed relief that there was no "deadly organized recreation." Others wanted group games, square dancing and "skits." At the half-way point, a two-day Parents' Weekend took nearly everyone away from camp, but the academic program seemed to replace the usual need for artificial entertainment. Indeed, several serious campers spent a large part of their spare time in the laboratories.

SCHEDULE

A typical day began at 7:00 A.M., and breakfast was served at 7:30, with the campers taking turns as table waiters ("cruisers"). Instruction followed housekeeping chores and lasted usually from 9:00 until 11:30 A.M., and again from 2:00 until 4:00 or 4:30 P.M. Lunch was served at 12:30 P.M., and dinner at 6:00. There were "snacks" at about 9:30 P.M. Younger campers then retired, but older ones were permitted to work later, the last being sent away at 10:30. On field trip days and, of course, on overnighters, the schedule was different.

Informality outside the academic periods was the rule, but class periods were conducted as lecture-discussions.

THE CAMPERS

In 1958, the lower age limit had been ten, but it was raised to eleven in 1959. It may be raised to twelve in 1960. The upper limit was fifteen.

It was readily apparent that young boys have a short span of attention; they react upon one another so that class periods were often filled with interruptions. But when the group was divided so that the younger boys were instructed separately, they could be kept interested by having a more active approach—more things to do and less of passive discussion. The girls (who were between thirteen and sixteeen in age) and older boys were much more eager to discuss such things as evolution, geology, genetics, ecology and other technical matters, and they could comprehend more of the topics which call for sedentary concentration.

The children had come to us from seven states in response to an advertisement in a large New York newspaper. Members of the Plattsburgh Association interviewed prospective campers and their parents at designated places in Plattsburgh, Albany, and New York. The campers were highly intelligent children from families in high socio-economic groups. The parents expressed the desire to have their children combine outdoor living with some sort of profitable instruction. Many had sent their children to expensive private camps in the past and found them only partly satisfactory. While the cost, $450, is higher than many camps—although lower than many others in the same geographical area—the parents making inquiry seemed to think it was reasonable considering the level of instruction, the equipment for scientific studies, the science kit which became the camper's permanent possession, the extensive trips and the close supervision assured by the camper-to-staff ratio.

SUMMARY

Only subjective opinions are available for judging the effectiveness of the camp. If parents' enthusiastic letters and verbal praise are a fair indication, the campers as a whole profited exceedingly during the six weeks' stay. Several of the pupils continue a correspondence with the staff regarding school work.

A few of the young boys brought to the camp an attitude which caused annoyance, and, in a few cases, actually disrupted project work through pranks. The staff

was sometimes nettled by the activities of the few who didn't have a mature outlook. As the days succeeded one another, the development of the group as a community became evident. Soon the common interest of the group came to bear on the pranksters, creating an atmosphere hostile to light-mindedness. We were reminded of the development of social consciousness in similar single-purpose groups described elsewhere [4, pages 239–40; 5]. Eventually, the minor annoyance ended when it was suggested that pranksters, if known, would not be admitted if they applied the next year. The appeal this kind of camp has for budding scientists was perhaps best revealed when the younger boys curbed their energies for "fooling around," and settled to purposeful work, discharging their boundless zest in approved ways after regular class time.

It should be said that the staff was continually impressed with the rapid comprehension of campers of all ages. It seemed obvious that in this selected group the concepts one usually associates with college level comprehension were readily mastered. This applied not only to principles of ecology, geology and conservation, to name a few, but also to deeper insights into scientific attitudes and procedures which the staff tried to teach by precept and example [6].

It is safe to say that the summer science camp for selected, talented children has much to offer. It is a logical solution to the problem of summer idleness among the gifted.

REFERENCES CITED

1. Irwin, Constance, *et al.*, "Year-Round Program; a Symposium," *National Education Association Journal*, 45:82–84, February, 1956.

2. ——— (Editorial), "Use the Schools the Year Around?", *Changing Times*, 10:13–14, April, 1956.

3. Pettit, Lincoln, "Biology Teaching in the Soviet Union," *American Biology Teacher*, 21: 277–281, November, 1959.

4. Frank, Laurence K. and Mary, *Your Adolescent at Home and in School.* Signet, 1956, 287 pp.

5. Makarenko, A. S., *The Road to Life; An Epic of Education.* Foreign Language Publishing House, 1955, 3 vol.

6. Pettit, Lincoln, "A Guide for Teaching the Scientific Method," *American Biology Teacher*, 15:31–35, February, 1953.

EXTENDING SCIENCE EDUCATION THROUGH ELEMENTARY SCHOOL CAMPING

JERRY BEKER
2206 Delancey Place, Philadelphia 3, Pennsylvania

"THAT which can best be learned in the classroom should be taught there, and that which can best be learned in the out-of-doors should there be taught." Dr. L. B. Sharp, known as the father of the Outdoor Education movement, has thus stated its basic guiding principle, maximal efficiency of school learning. School camping is an extension of the regular curriculum to the out-of-doors, but an integral part of that curriculum.

The school camping program enables regular classes, with their teachers, to spend a period of time living, working and playing together in a relatively natural camp environment. In effect, it represents an extended field trip into a natural laboratory situation with raw material for many, if not all, areas of the curriculum, but especially science. Perhaps the most common pattern is for the school camping experience to last for one school week, from Monday morning until Friday afternoon, for fifth, sixth or seventh grade classes. Some schools have adapted school camping programs to the secondary level, and some have introduced

outdoor education experiences, usually of shorter duration, below the fifth grade as well. Of course, as with any effective field trip, much time is spent in the classroom both before and after camp in correlating the camp program with class activities, and consolidating learning. Effective school camping is an integral part of the total school experience.

Many public school systems as well as private schools across the country have implemented school camping programs. Especially noteworthy is the progress that has been made in such states as California, Michigan, New York, and Texas. Many thousands of children annually attend camp during the school year, usually with their classroom teachers as well as other leaders, as a part of their regular curriculum. New York University's School of Education and other groups are providing leadership and guidance for school systems anxious to get started in the program. Nationwide, the picture is one of rapid expansion of this significant educational innovation.

The most self-evident possibility for extension of the curriculum through school camping is in the area of the sciences. At camp, the subject matter in this field, quite literally in many cases, "comes alive" for the students. The natural environment itself is available to be studied and shared—the sources are primary, although they should be supplemented by books and other secondary materials. Most important, the subject matter has meaning for the child; it is a part of his life. Motivation is no longer a problem.

Almost every area of natural science, if not every one, can be successfully studied at camp—with greater efficiency of learning than in the classroom. Of course, these learnings can be broadened and deepened in the classroom later. The school camp is the laboratory where observations are made first-hand. Ways in which some areas of science may best be studied at camp are presented below. The material is not complete but suggestive; the possibilities are only limited by the limits of teachers' and students' imaginations.

Astronomy is one of the most obvious. The children are at camp "round the clock," and are available to make observations at night. The stars, planets and moon become part of the collective class experience, and children are taught while looking at the sky itself. Facts are learned more easily in a situation such as this, and new feelings are also experienced and learned. There is a spiritual appreciation that is part of knowing the night sky fully, and it cannot be learned from a textbook.

The classroom model of the sun, the moon and the earth makes better sense when children can compare it with an actual sunrise and sunset and the travels of the moon. The spinning of the earth, the revolutions of the moon around the earth and the earth around the sun begin to have meaning for children in terms of their own lives. Questions arise, again sometimes with spiritual implications, and new learning takes place.

In times like these, we must also turn our attention to man-made celestial bodies. Artificial satellites may be observed, and their study has scientific implications that may lead into many areas such as space travel, rocket operation, jet propulsion, gravity, and friction. In addition, a natural correlation is provided between science and current events. The importance in today's world of education in general, and science education in particular, may thus become clearer to children.

At camp, children are also able most effectively to study meteorology rather than about meteorology. They are living in the out-of-doors, on a twenty-four hour per day basis, and are in an ideal position to make their own observations, using instruments and directly observed natural indications. The whole interesting area of weather and climate is opened to them in a natural, indigenous way. Understanding the weather

and even forecasting it becomes important to them, since it has a great influence on their life and program at camp.

The study of soil and water may also be made more meaningful and fruitful in the laboratory that is the school camp. It is natural to ask about the substances that make up "terra firma" when one is at camp, much more likely (and much more relevantly) at camp than in the classroom. This may lead into the whole area of chemistry, for example, or into the life sciences.

Another science whose raw materials are part of the camp environment is geology. It is one of the most fascinating to children, when they can be the geologists themselves, —collecting rocks, chipping out fossils and the like. In this situation, the children are clamoring for learning and need only resources—books, charts and the like—to find the facts they want. Perhaps the wisest teacher is the one who doesn't tell them everything, but helps them "look it up."

Botany and zoology are two of the major areas of science that can be studied most effectively in the school camp setting. Plants and animals abound, and children's interests are attracted by them. Not only can plants and animals be studied "in the flesh," but they are in their natural habitats as well. One of the major contributions to children's understanding of life that camping is equipped to make is in just this area, ecology. Once children can understand and get a "feel" for the interdependence of life in a given habitat, including all the limiting factors such as climate, food, shelter and protection, they are much better equipped to study and understand other forms of life. The principles involved—interdependence and balance—have the broadest possible implications for students.

At this point, we begin to see the implications of this kind of study of science for the social learnings of students, for interdependence is a vital principle in this regard. But there is another whole area of scientific learning and experience at school camp, transcending those discussed above, with the most direct and significant social implications. This is the area of conservation. Children at school camp learn about conservation in part by actually doing conservation projects, by talking with resource people whose work is in the field of conservation, and by study. They are concerned with all major areas of conservation —soil, water, wildlife and forests. At all times, underlying reasons for conservation "Do's" and "Don'ts" can be stressed, so that the children learn the scientific bases for what they are doing.

Conservation units include such items as the causes, dangers and control of soil erosion. Learning is consolidated as children actually apply erosion control techniques. They build small dams along streams to impound water and improve fish habitats. They build brush piles for animal shelters, fell trees to thin the forest when necessary, and do other real conservation jobs. Scientific learnings may accompany all of these activities. The environment provides the resources, the laboratory. Of course, the teacher's job as guide and interpreter remains a requisite if learning is to be more than observational and to have real meaning for students.

We have examined a few of the more obvious ways in which science can be more effectively studied using a natural outdoor laboratory. More strictly physical sciences can also be involved, as when a group faces the problem of how to move a large, heavy log that has just been cut. Or, how long it takes a stone to fall from the top of the cliff. Or, how to build and brace that log bridge over the stream. But let us look at the program in the context of an actual elementary school science curriculum.

School camping is perhaps most common at the sixth grade level across the country, and this level provides us with a good example. One state's (New York) Sixth Grade Science Outline lists seven major "problems," at least five of which seem directly related to the kinds of learnings that can be developed naturally through the

use of school camp as a laboratory. Certain aspects of the two others, electricity and sound, may also be relevant here but will not be considered in detail. Efficiency of learning is the goal, and units that can be most enhanced through school camping are our primary concern.

The first problem is titled, "Animals Need Food for Growth and Energy." The aims of this unit are listed as:

1. To show the close relation of plants and animals;
2. To learn how animals survive;
3. To find what cells are;
4. To show how animals make use of their food and oxygen.

Suggested approaches are:

1. Find pictures of animals in their natural surroundings;
2. Observe how animals are adapted to their surroundings;
3. Discuss their own pets and animals familiar to the group.

The teaching of this unit can clearly be facilitated through school camping, since it ties in closely with the natural habitats of animals.

The problem, "What Causes Changes in Climate and Weather?", has been discussed above. Likewise, we have mentioned astronomy, on which another problem, "Is the Sun a Member of Our Galaxy?" is based. The aims listed for the unit are:

1. To find what is beyond our solar system;
2. To find what are constellations;
3. To show the nature of our galaxy;
4. To find what is beyond our galaxy.

Suggested approaches are:

1. Read legends connected with the constellations and find out how they got their names;
2. Look for interesting articles in newspapers or magazines;
3. Observe the sky on a clear night and try to fix in mind the positions of a few of the brightest stars.

It can readily be seen how many of these kinds of aims and approaches can be enriched and made to "come alive" at camp.

"How Has Man Changed Some Plants and Animals So That They Are Better Suited to His Needs?" is a problem that can be most effectively studied at a school camp which includes a particular kind of resource, a farm. In this situation, children can actually observe the techniques and results of artificial selection, grafting, hybridization and artificially induced mutations. They can become acquainted with farm plants and animals, in part through actually working with and caring for them. Milking the cows, feeding the chickens and harvesting the wheat are some of the kinds of experiences that add new depth to learning about this vital aspect of life. The theoretical aspects become more meaningful in this context. The comparison of domesticated plants and animals with wild ones for purposes of human consumption can be made easily and vividly in this kind of situation.

The final problem is entitled, "Our Health Should Be Safeguarded," and it is in this area that school camping has a special contribution to make in the very nature of things. For the children plan their trip in the classroom before they go. Among their concerns are such matters as, for example, menus, rest and sleep, cleanliness and sanitation, and clothing. These all provide natural opportunities for learning about health. The children usually plan their menus with the help and guidance of the school dietician. She may supply them with the facts about nutrition, such as the kinds of food needed in the basic daily diet, and the reasons for these requirements. Students learn these facts because they need them to use in devising the specific menus for their trip.

Frequently the school nurse is also called in as a resource person. She may discuss with the children their needs for rest and sleep, and the value of rest and sleep to the body, as an aid in their planning of a realistic and intelligent time schedule. Likewise, the need for clean hands at mealtime, the importance of thoroughly disinfecting toilet facilities, care not to spread germs through coughing and sneezing, and similar concerns may be discussed. The values of proper clothing, exercise, fresh air and the

like can also be brought into the curriculum naturally in this situation. Of course, for scientific learning to occur, all of these leads must be explored in depth with the children, rather than merely stated or memorized.

But the real essence of scientific learning, especially in the elementary school, involves the scientific attitude and process, which begins with scientific curiosity. For the answer to the scientific challenge of our day does not lie in trying to make every sixth grader a compendium of scientific knowledge. What we must do is inspire young minds to ask questions and to seek answers. We must reward both the asking and the answering. It is in this area of scientific concern that school camping may make its greatest contribution, at least on the elementary school level.

School camping starts with the unfolding of the wonders of the natural world. Students need not "fight" their textbooks. The books are resources, and reward their curiosity with answers, their speculations with support or deeper insights. Teachers help students to ask questions, to reason out answers, and to check conclusions.

The most vital element, the stimulation and motivation, comes from the presence of the raw material of learning, life itself. Furthermore, the learning is non-segmental, just as life itself is non-segmental. There is a natural correlation of subject-matter fields. For the scientific at camp cannot be divorced from the social, the verbal or the quantitative. It is all of a piece. Insofar as life itself is challenging, insofar as children are inherently seekers of knowledge, so can an effective program of school camping tend to enhance the development of our future citizens in the scientific as well as other vital areas of life.

CONCEPTS OF LIGHT AND SOUND IN THE INTERMEDIATE GRADES *

PEARL ASTRID NELSON

Boston University School of Education, Boston, Massachusetts

THIS investigation was another expedition into the general quest for knowledge of how children acquire science concepts, the level of their understanding, and whether socio-economic background and intelligence are related to this learning. It was decided to use the two areas of *Light* and *Sound* before and after a planned teaching program as the material for the study, and 118 boys and girls from the intermediate grades of the elementary school as the children to be studied. The investigator gave a workshop in physical science to the teachers of two private schools where no previous instruction in physical science had taken place. Since the pupils in these schools were considered to be of superior socio-economic background, a school of lesser socio-economic environment was chosen for reasons of comparison. The workshop met for eight one-hour sessions in consecutive weeks, and later the investigator spent some time with the teachers and in the individual classrooms for the purpose of establishing rapport with the pupils and for giving necessary help to the teachers. Each teacher was given a selected list of experiments and directions compiled by the investigator, and was allowed to proceed with the teaching by his

* Based on a doctoral dissertation entitled: *The Acquisition of Concepts of Light and Sound in the Intermediate Grades,* Pearl Astrid Nelson, 1957. Copies are on file in the library of the School of Education, Boston University, Boston, Massachusetts.

own method or methods. The investigator did not teach the children at any time. Materials and books were provided if needed. Worksheets were given to the teachers on which were experiments and experiences considered suitable for elementary school science instruction in *Light* and *Sound*.

The teachers did not begin the teaching of *Light* and *Sound* until the writer had interviewed each child individually and tape recorded his responses to interview questions and to the Object-Classification Tests.

Tests Given to the Pupils. The tests given to the pupils before instruction in the areas of *Light* and *Sound* were five in number: (1) The Otis [1] Quick-Scoring Mental Ability Tests, Beta Test, Form A; (2) The Multiple-Choice Word Classification Test, constructed by the writer; (3) The Oxendine [2] Sound Test; and (4) and (5) the two Object Classification Tests in the areas of *Light* and *Sound* which were also constructed by the writer. The responses to the Object-Classification Tests as well as to both interviews were both tape-recorded. The same tests, with the exception of the Otis, were given after instruction also.

CONCLUSIONS

1. Instruction produced a significant increment in the understanding of principles related to *Light* and *Sound*. Certain principles of Wise [3] supplemented those of Robertson,[4] which have been considered adequate for the elementary school. In the area of *Light*, the gain in principle-understanding was 270 per cent; in *Sound*, the per cent of gain was 248 per cent.

2. In concept-gain, as revealed by verbalization during the Object-Classification tests, the *Sound* concept-gain was 120 per cent; in *Light* the per cent of gain was 260 per cent.

3. The Sound Test showed a significant improvement directly related to the grade of the pupil.

4. Pupils from the relatively high social-status schools and pupils from the relatively low social-status school showed about the same amount of improvement.

5. Grade and social status are not related to the amount of improvement on the various tests, but they are directly related to the level of performance, both before and after instruction.

6. All tests are significantly related to one another and to intelligence.

7. Sex differences did not affect test-scores either before or after instruction.

8. There is a difference between the scores on the intelligence test between the two socio-economic groups, but the mean scores of both groups lie within the range of normality.

9. The pupils named *books, people, television* and *school* as important sources of their science information.

RECOMMENDATIONS

It is to be noted that this study reveals that many concepts and scientific principles were stated by children with evident pride in their knowledge before any instruction in the two areas of *Light* and *Sound* had been begun. The fact that some children receive no real instruction until after elementary school does not mean that their curiosity has been atrophied. Children's curiosity has long been known to be a driving force in the teaching of principles of physical science. This was evidenced in the performances in the Object-Classification Tests. The investigator noted that caution was used in an-

[1] Arthur S. Otis, *Otis Quick-Scoring Mental Ability Tests*, World Book Company, Yonkers-on-Hudson, New York.

[2] Herbert G. Oxendine, *The Grade Placement of the Physical Science Principle, "Sound Is Produced by Vibrating Material," in Relation to Mental Age*, unpublished Doctoral Dissertation, The College of Education, Boston University, 1953.

[3] Harold E. Wise, *A Determination of the Relative Importance of Physical Science for General Education*, Doctoral Dissertation, University of Michigan, 1941.

[4] Martin Robertson, "Selection of Science Principles Suitable as Goals of Instruction in the Elementary School," *Science Education* (February–April, 1935), Vol. 19, No. 4, pp. 65–70.

swering the reasons for classifications. Many of the children also showed willingness to change opinions after instruction had taken place. The examples of suspended judgment exemplify scientific methods and critical thinking both of which should be encouraged in problem-solving. It should be realized that many science experiments in the elementary school are not intended to increase scientific knowledge primarily but aim at developing scientific methods or attitudes. For this reason, the Object-Classification Test may be used by teachers to encourage clear thinking and objectivity.

This investigation has revealed the fact that the pupils were able to verbalize principles other than those deemed suitable for elementary school children. It may be well for science educators today to reevaluate thinking in regard to how much science-learning may be expected from the intermediate grade children of the elementary school. It is possible, then, that some future investigator may wish to revise the present listing of elementary school science principles in recognition of the fact that children of today may be able to understand more science than is now acknowledged.

This study has shown that, if most children are similar to those of this study, they have a wide knowledge of their surroundings, and the sources used by them as they learn science may be increased by teaching and guidance in the elementary school. Ability to use information may vary from child to child, and, under proper guidance, the pupils will be able to evaluate the various sources of their knowledge. When school days are over, this ability to evaluate will continue. Evaluation, this power of judgment, is not an inborn trait; it must be acquired. By reviewing, reporting, discussing and listening, the process of judgment is learned and standards are built.

Science Environment. There are indications from the interview technique used in this study that elementary school teachers should allow the child to talk in an atmosphere of acceptance, because verbalization may bring out science information and may also reveal ***how children think.*** Certainly this would help the teacher to teach elementary science more effectively. It is desirable that there be resource and reference material in the classroom readily available. Siblings and parents were found to be excellent sources of information for the child who is genuinely interested in science.

Since the elementary school teacher and the school itself were credited with giving much help in science learning, the teacher can do a great deal to help and guide each child toward more efficient use of his environment for sources of information.

Since there was no significant difference in the test results before and after the teaching period between the higher and lower socio-economic group, it may be wise for us to consider the indication that elementary science may be "culture-fair" and is not dependent upon family or cultural background.

Use of the Object Classification Tests. A careful examination of the items in the Object Classification Tests will reveal that the models are all within the experience of the child, and may be used as regular classroom science equipment by the teacher. The analogies, or pairing of the models, may be used as a means of evaluation of science teaching in the areas of *Light* and *Sound,* as a stimulus to classroom discussion, or as subjects for individual verbalization and revealing of understandings in the two areas. The models may be used individually as well as in pairs for problem-solving situations, and for investigations into types of thinking. Many informative patterns can be discovered by the use of the Object-Classification Tests, and although the use of the tape-recorder facilitated this particular investigation, a long-hand answer sheet may be used by the teacher who wishes to keep records of the individual achievements of pupils. A study of individual scores will provide diagnostic information to the teacher on the child's science progress. Similar tests may

be built by teachers or other investigators to determine the formation of concepts in other science areas.

A study parallel to this one with younger or older children may prove of interest in order to obtain a portrait of how the emphasis on the sources of science information changes with the age of the child.

If another field of knowledge, as arithmetic or social studies, were to be investigated in a similar manner, would the sources of information change?

Do adults remember where they derived their science knowledge? A study of a mature age group with interviews similar to those conducted in this investigation might reveal interesting sources of science information.

Since the interview method used in this study was highly successful, further studies in elementary science using this method may be of great interest.

We may assume that this study has revealed the fact that *children do know something about scientific principles,* and that knowledge is not merely casual and observational. The game-element was extremely high in the Object-Classification Tests. Things known are strongly related to sensory experiences and since the Object-Classification Tests provide actual manipulation of science materials, it is recommended that the school provide the environment or the materials for such experiences.

Wide Scope of Elementary Science. There is no experimental evidence that content from the biological sciences is easier for children than content from the physical sciences, and therefore better adapted to elementary school. An analysis of the statements concerning *Light,* particularly before instruction had taken place, indicated that the children of this study thought of *Light* in connection with astronomy as well as with energy-transfer and relationship to life. In this respect, elementary teachers should become aware of the fact that the topics and units on *Light* in the science textbooks may cover only a narrow segment of the possible information, sought by and useful to children, on the subject. It would be worthwhile searching also, to see if other science areas are treated in too limited a manner in the textbooks for elementary science.

Ecological Studies of Children. This investigation should contribute towards the many ecological studies of children which are now in progress. These studies include getting a better understanding of children's behavior patterns as they react to our modern culture and mode of living. The interpretation of the impacts of these studies upon the work of the classroom teacher is one of great importance. This study indicates how teachers can determine the sources of information children use, and from that knowledge, adjust the curriculum for most efficient learning. It would be illogical to assume that this means that the shortest way would be the most economical or affective. It is hoped, then, that this present investigation will supplement the child-interest studies dealing with the child's thinking in elementary science.

Science Workshops. The efficacy of science workshops for elementary teachers may be emphasized also as a concomitant part of this investigation. Physical science teaching in the elementary school has not been too popular in the past, and although the more recent science textbook series are devoting about one half of their material to the physical sciences, there are still teachers who insist that elementary science is completely biological, and teach nature-study to the exclusion of physical science. For these teachers especially, a science workshop of the type given to the teachers of this investigation should prove of worth.

This is the only study known to the writer where teaching to a maximum saturation point has been undertaken: Other studies using this technique might prove revealing in other science areas.

BASING INSTRUCTION IN SCIENCE ON CHILDREN'S QUESTIONS: USING A WONDER BOX IN THE THIRD GRADE

Ben A. Bohnhorst and Prentiss M. Hosford
Oglethorpe University, Atlanta, Georgia

PURPOSES

The purposes of this study are: (a) to describe certain procedures which one third grade teacher employed during the 1957–58 school year to teach science to her children, and (b) to compare the performance of her children on the National Achievement Elementary Science Test with the performance of the children in the other third grade in the same school during the same year. As will be indicated below, results on the tests suggest that the children who experienced the special procedures to be described also achieved significantly higher scores on the tests at the end of the year than did the children in the other third grade. The fact of this superior achievement makes the special procedures worthy of special attention.

SETTING OF THE STUDY

The setting for this study was the Spring Street School in Atlanta, Georgia. During 1957–58, the Atlanta Public Schools began a series of closed-circuit educational television programs, a portion of which were lessons in elementary science beamed at the children in the third grades. Part of the data collected by the school system to evaluate those programs were scores on the National Achievement Elementary Science Test, given both near the beginning and the end of the school year (in October and in May). The children in both the third grades at the Spring Street School regularly viewed these TV science programs once a week in the school auditorium. Both the teachers related their classroom experiences to the TV series as well as they could, both by preparing the children for viewing programs and by following up the lessons with classroom demonstrations, experiments, and readings.

So with regard to the TV lessons, the children in the two third grades at Spring Street had roughly the same experiences. But with regard to certain other experiences within the classroom, the instructional programs in science differed. One teacher organized her science program around units in a standard classroom set of elementary science texts for the third grade, relying on her guidebook for suggestions for implementing and enriching the program. The other teacher used a Wonder Box to gather the wonderings and the questions which were in the minds of her children. Then she organized her classroom units and teaching activities around the children's questions, selecting materials and activities appropriate to studying these questions. It is this use of a Wonder Box which is to be described in some detail here.

USES OF THE WONDER BOX

The teacher who employed the Wonder Box has herself expressed her values and purposes in employing this approach:

> A visitor in a third grade classroom at Spring Street School in Atlanta remarked, "How intently the children are working on so many different things!" One reason underlying this observation was that one of the teacher's highest values, second only to the happiness and feeling of security of every child, was intellectual curiosity.
>
> The minds of eight year olds are filled with interests as wide in scope as their real and vicarious experiences will allow them to be. They ask both about concrete things and about the abstract. They are curious about such things as animals, people, plants, industries, history, social conditions, travel, and space. As they satisfy their inquisitiveness, they are often motivated in the use of many study and social skills in learning to solve problems of interest to them.
>
> This group of children possessed many kinds of

interests and levels of curiosity, which were apparent in a number of ways. They presented a great concern to their teacher—she felt very responsible for their growth after studying them, for each individual appeared so unique. There was evidence of much questioning and wonder about things around them.

One objective the teacher had was to be able to help the children understand that it is good to wonder about things—that our life today is as good as it is because people have wondered. The children were to feel that their teacher was always ready to listen to their thoughts.

Interests seemed to be "caught" by the children from other children, and "Sharing Time," formerly devoted primarily to telling about an incident or to showing things brought from home, was often now a time to share questions and problems. In anticipation of ideas which might come to a child's mind at a time when the group was engaged in an activity which should not be interrupted, we made a Wonder Box. In it were placed written expressions of children's minds engaged in thoughtful questioning. At certain times, the Wonder Box was opened, questions were discussed, and plans were made for individual or group investigation to answer them.

A representative list of questions which this teacher's third graders placed in the box is as follows:

What is the sun made of?
I wonder why the snow is in different shapes.
How does sound fade away?
I wonder how a telephone works.
How do people shut their eyes and see a picture?
I wonder where I came from and where I am going.
I wonder how God made the world.
I wonder about the sky.
How fast does electricity travel?
How can oil be changed into gasoline?
I wonder what is inside of somebody.

Such questions clearly indicate the range and scope of the curiosity of third graders.

The teacher encouraged the children to use their Wonder Box. From time to time she reminded them of its presence in the room. On some occasions the class took special time to think of questions for placing in the box which were related to the topic of the moment. Therefore some of the questions were spontaneous and some grew out of experiences in class.

Employing the children's questions to give direction and structure to the classwork demanded of the teacher that she provide in the classroom the richest wealth of reference materials that she possibly could. Indeed, much of her effort was expended in the gathering of wide varieties of materials for the classroom. She worked very closely with and received great help from librarians in the public libraries in Atlanta.

Some questions she helped individual children answer on their own, guiding them in finding and using materials which might help them. Often she was able to group several questions into a unit on which the class as a whole or some sub-group within the class could work together. For example, the following questions on the sun were gathered together as a basis for a unit of study:

1. Why is the sun so hot?
2. Why does the sun shine longer in summer than in winter?
3. What is the sun made of?
4. Why is the sun real hot in the summer?
5. How long will the sun be shining?
6. Why does the sun look yellow?
7. How does the sun get hot?
8. Which layer of the sun is coolest?
9. When was the sun made?
10. Is the sun red or yellow?
11. How does the sun give light?
12. How much heat does it have?
13. How far does the sun penetrate?
14. What goes on at the sun?
15. How far away is the sun?
16. What is in the middle of the sun?

Such questions as these, then, formed the basis for structuring the lessons in science in the classroom in which the Wonder Box was used. In the other class, greater reliance (relatively speaking) for structuring classroom activities was placed upon the prepared organizations built into the textual materials by the professional authors of the children's science books and the teacher's guidebook.

TEST RESULTS

For purposes of distinguishing easily between the two third grade groups, let us refer to the teacher who used the Wonder Box as Teacher X and her class as Class X, and to the other teacher as Teacher Y and her class as Class Y.

TABLE I

Class	N	Mean	σM
X	34	62.68	2.77
Y	37	63.59	2.19

Table I shows the N's, the raw score means, and the standard deviations of the means for Class X and Class Y on the National Achievement Elementary Science Test given in October 1957. There is no statistical significance in the difference between these observed means. There seems to be no basis for rejecting the assumption that both Class X and Class Y were adequately representative samples of the same population in October.

Table II shows the means and standard deviations for the same groups on the same test in May 1958. On this test the mean for Class X is statistically significantly higher than the mean for Class Y ($P<.05$).

TABLE II

Class	N	Mean	σM
X	34	89.62	3.37
Y	37	81.19	2.52

$$M_x - M_y = 8.43$$
$$\sigma M_x - M_y = 4.21$$
$$C.\ R. = 2.002$$
$$P < .05$$

DISCUSSION OF RESULTS

The difference between Class X and Class Y in May has statistical significance (i.e., it is not likely that such a difference would be obtained by chance). The question is how to interpret this difference—what *caused* the difference?

The fact is that there is no clear evidence in this situation as to what caused the difference observed in Table II. There are many possible reasons why this difference may have resulted. For example: (a) Teacher X may have had more enthusiasm for science teaching than Teacher Y, whereas Teacher Y may have imparted more enthusiasm in some other area of the curriculum, (b) Teacher X may have devoted significantly greater portions of time to teaching science during the year, (c) Teacher X may be relatively better prepared in the area of science. Any or all these factors, plus several other factors, may have contributed to the resulting difference. Therefore one is not able definitely to conclude that using the Wonder Box in Class X is what accounted for the difference in scores in May.

However, there is at least a clear *suggestion* in these results that basing a science program on the questions and wonderings of children leads to greater achievement. What seems to be indicated is further research, including a carefully constructed experimental design to control more rigorously the several other variables which may have influenced these results. So far as one can tell from informal contact with the teachers and their programs during the year, the key factor distinguishing the two programs was in fact the difference in approach, rather than differences in enthusiasm, emphasis, or competence in the field of science. But, lacking controls, one cannot be sure. On the basis of the present results, however, one might reasonably hope that another more carefully controlled study would verify the present suggestion: that basing instruction on children's curiosities, wonderings, and questions enhances their learning in science.

It should be noted that according to the fourth grade norms (appropriate to use at the end of the third grade) published with the National Achievement Elementary Science Test, the May mean for Class Y represents a rank in the 71–80 percentile range, and the May mean for Class X represents a rank in the 81–90 percentile range. These data indicate the general excellence of teaching in both classes.

Finally, the reader may be interested in examining other recent reviews of science teaching in the elementary grades related to this study. The bibliography lists a number of the most recent reviews of research, which also have useful bibliographies [2, 3, 4, 5, 6], and also a number of recent provocative

discussions of ways of teaching elementary science [1, 7, 8].

BIBLIOGRAPHY

1. Bingham, N. E. "How Can the Elementary Science Program Reveal, Nourish, and Maintain Science Talent?", *Science Education*, April, 1956.
2. Dunfee, M. and Greenlee, J. M., *Elementary School Science: Research, Theory, and Practice.* National Education Association, Washington, D. C., 1957.
3. Hill, K. E. "Research Concerning the Nature of Children's Ideas in Relation to Scientific Phenomena," *Science Education*, October, 1957.
4. Mallison, G. G., and others. "Recent Research in Science Education" (a symposium), *School Science and Mathematics*, November, 1957.
5. Matala, D. C., and McCollum, C. G., "Science in the Elementary Grades," *Review of Educational Research*, October, 1957.
6. Obourn, E. S., and others. "Fifth Annual Review of Research in Science Teaching," *Science Education*, December, 1957.
7. Popendorf, I. "Creativity in the Teaching of Elementary Science," *School Science and Mathematics*, April, 1958.
8. Young, D. "Some Techniques for Identifying Children's Science Interests," *School Science and Mathematics*, June, 1957.

SCIENCE AND MATHEMATICS BACKGROUNDS OF ELEMENTARY SCHOOL TEACHERS YET TO COMPLETE THE BACHELOR'S DEGREE

MAURICE FINKEL
Northeast Missouri State Teachers College, Kirksville, Missouri

NATURE OF THE PROBLEM

NOT all the practicing school teachers returning to college during evenings and summers are working on graduate programs. Many of these folk are still completing credits for their bachelor's degree even though they may have been teaching for many years. Still others are anxiously working to satisfy minimum requirements for some sort of provisional certification which temporarily does not compel them to have more than about two college years education. What of these people? How well are they able to teach the mathematics and science expected at their level of instruction?

For the most part, this group represents an older segment of the student body, who, in addition, feel quite weak in the area of science and mathematics. Despite this fact, it is apparent that many of them would not take any science and mathematics courses to help themselves in their position if they did not have to do so. Coming back to college, these older students are beset with problems not usually experienced by youngsters right out of high school. It is more difficult for them to learn. Their retention seems lower. They are concerned about keeping up a home away from school, about their children single and married, about the heart conditions of their husbands and so on. They have to contend with the physical limitations typical of that age group. Some are even worried about their next job, having just lost theirs due to the integration of their school.

SOME INTERESTING DATA

During the summer, 1958, at the Northeast Missouri State Teachers College, 47 students who belonged to this group participated in a study. One-half of them had taught at least nine years and one-quarter of them had taught 14 years or more. Seven of them had between twenty to thirty years of teaching experience. None had their degrees.

As a whole, their high school science and mathematics background was good. The vast majority of them had taken two to three courses in mathematics and one to two courses in science. However, 25 per

cent of the science courses were taken before 1924, 50 per cent before 1933 and 75 per cent before 1946. In regard to courses taken in mathematics, 25 per cent were completed before 1922, 50 per cent by 1930 and 75 per cent before 1940. It may be concluded with some validity that most of the high school courses taken by these people in science and mathematics are not likely to be very helpful in the present completion of related studies in college. For similar reasons, it is probable that these courses have not been too helpful in their teaching situation.

Over half of these teachers taught in rural schools where each had more than one grade to teach. About 20 per cent had all eight grades in one classroom. Many of these teachers indicated that they learned the science they taught from the elementary science readers used by the students themselves. Certainly, the adequacy of their preparation in science is to be questioned!

About one-half of these teachers had completed 7.5 semester credits in college science while only 25 per cent of them had five or fewer semester credits in the field. Again one-half had completed five semester credits in college mathematics while only 25 per cent had finished 2.5 semester credits or less in this area. It should be stated here, that few of these college courses in mathematics indicated were in algebra or more difficult courses. By far, most of the courses were in the teaching of arithmetic and in review of arithmetic up through the 8th grade. On the other hand, not a single teacher had had a course in the teaching of science. By far, most of the college course work taken in science was part of an integrated general science course offered by the college rather than old standbys like physics, chemistry or biology.

While the vast majority of the college science courses were completed by or before 1951, 25 per cent of such courses were taken prior to 1940 and 6 per cent prior to 1930. About 31 per cent of all the college mathematics taken by these people were completed before 1940. It may be questioned as to whether such courses in college science or mathematics completed eighteen years previously are likely to be very helpful in the present day classroom teaching situation of such teachers or in the completion of related college courses at this time. The teachers of this group hint at this when one out of five indicated that the courses of college science and mathematics that they took in college were of very little help to them in their teaching situation.

The result of this particular type of background may be reflected quantitatively by the number of hours of science and mathematics that they taught in their classrooms each week. Fifty per cent averaged only two hours of science per class per week and three hours per week in the teaching of mathematics. One third of them taught science less than one hour a week. This situation is obviously aggravated when a student may have the same teacher for as many as eight of his twelve years of schooling. This is the nature of the problem. What can be done?

PROGRESS TOWARD A SOLUTION

First, it should be stated most emphatically that the teachers of this group are not to be condemned. Rather, they should be given considerable credit for year after year coming back to college in summers and evenings to finish their education at great expense to themselves, not to mention inconvenience. This also in view of the fact that as rural school teachers on some sort of provisional certification, they have about as low a pay scale as any professional group. It has not been easy for them to save money on their salary only to spend it on a college education in the summers. This sort of situation becomes harder as one becomes older since they are concerned with home and family responsibilities as well as their own physical limitations.

Following are some suggestions that may ease the situation:

1. Most states issue provisional certificates based on about two years of college work. These certificates should be renewable only if there is apparent progress on the part of the teacher toward full certification.

2. Full certification should include:

(a) Approximately nine semester credits of college mathematics including the fundamentals of arithmetic, algebra, and geometry as well as methods for the teaching of arithmetic up through the eighth grade.

(b) Approximately twelve semester credits of course work in science including: earth science, astronomy, general and human biology, chemistry, physics, conservation and nature study, history and philosophy of science as well as a methods course in the teaching of science. The latter should be designed about experiments and demonstrations that could be used to advance the general principles of science at an elementary level.

3. State boards of teacher certification should provide a special certification in the teaching of science at an elementary level. Individuals with such a specialty could be a roving teacher within one or more schools. In addition to teaching special classes in science, such an individual could advise the regular teacher in the field of science.

4. The state boards of certification must effect some control on the science courses used for the fulfillment of requirements. Due to the changing nature of science, courses taken over ten years ago should not be acceptable unless additional and more recent course work in science has been completed. Certification should be renewed only if the applicant has taken measures acceptable to the board for keeping up to date in science. Correspondence courses may be a great help to the teacher unable to attend school away from home.

In response to certification requirements set up by the state boards of certification, colleges would have to include in their respective programs the necessary courses. This is not likely to cause any hardship among the colleges since, in most cases, they already offer the courses needed. The problem has been making students take such courses.

5. Finally, the state boards of education should attempt to do away altogether with the one room school house. Any situation where a student may have the same teacher for a number of years is apt to be bad since the student is limited by the inadequacies of that teacher. Any teacher that has to teach more than one grade during the day is given a burden that only the most unusual teacher could handle. Such a situation is not likely to bring about superior teaching for the teacher or superior learning for the student. Consolidation is the only answer. With the advent of modern vehicles, no student should have to go to a one room school. This situation has been with us far too long and should be eliminated.

In conclusion, there is increasing evidence that the colleges today in many instances are being called on to teach the mathematics and science that should have been taught in the high school. This is because the elementary and secondary school has not fulfilled its purpose in educating the whole child. For one thing, to give a child twelve years of superior education one must have superior teachers in a superior classroom situation. This is rarely the case. Any situation where the classroom teacher uses only the elementary textbook to learn what to teach is a tragic situation. The high school must become less of a social club and more of an academic institution. No high school diploma should be issued to a student who cannot read, spell, calculate or use grammar correctly at a twelfth grade level. These are minimum requirements. High school students who cannot pass tests on these fundamentals should be only given a high school certificate of attendance. The high school diploma should mean that the individual having it has exhibited proficiency in academic work to the level where he may be graduated.

No individual should be certified provisionally or otherwise who cannot pass tests in the broad fields of language, mathematics, science and the social sciences. Such tests should be based on college courses ordinarily required of liberal art students during their first two years of college. This would at least require academic proficiency of all teachers to be above the high school level. We can do no less.

BOOK REVIEWS

BROWN, STANLEY B., AND BROWN, BARBARA M. *The Story of Dinosaurs.* Irvington-on-Hudson, New York: Harvey House, Publishers, 1958. $2.95.

This dinosaur kit consists of a guidebook for young scientists, two plastic dinosaurs (Brontosaurus and Tyrannosaurus), five genuine fossils and the authors' *The Story of Dinosaurs.* This particular kit has fossils of petrified wood, horn coral, a brachiopod, a crinoid stem, and a piece of dinosaur bone. This material should greatly enhance the enthusiasm of youngsters studying dinosaurs and fossils and ancient life in general.

The content of the book itself is a quite complete coverage of the history of dinosaurs: how fossils were formed, ancestors of the dinosaurs, the many kinds of dinosaurs, the mystery of their disappearance, a list of North American Museums, a pronouncing dictionary, an index, and a list of books to read.

The book was checked for scientific accuracy by Mary B. Pasturis of the American Museum of Natural History. Illustrations by Don Bologuese add much to the general appeal and understanding of the textual material.

Content is suitable for upper grade—junior high school students. The book is highly recommended for the science bookshelf.

Dr. Stanley B. Brown is a noted classroom teacher of the University of California and a member of N.A.R.S.T. and his wife Barbara Brown is an experienced classroom teacher and consultant in science education.

WARE, KAY; SUTHERLAND, LUCILLE, AND OTHERS. *Stars, Fishes, Reptiles and Amphibians, Prehistoric Animals, Mountains and Volcanoes, Jungle Animals, Sea Shells, The Sea, Airplanes, Unusual Birds, The Earth, Space Travel, Insects, Flowers, Butterflies, Birds, Rocks and Minerals,* and *Trees.* St. Louis, Missouri: Webster Publishing Company, 1957–1959. 32 pages each.

The complete title of each of the above book is for example, *Let's Read About Trees.* The whole series is entitled *Webster Classroom Science Library.* Kay Ware is General Consultant and Lucille Sutherland is Director of Elementary Education for the St. Louis, Missouri, Public Schools. A third contributor to each of the booklets is a St. Louis classroom teacher. Each of the booklets is beautifully illustrated in color and/or black and white.

The textual material is intended to give the teacher and pupil a brief, accurate, authoritative overview of the particular science area covered in the book. On the inside back cover of each booklet is a list of things to talk about and a list of things to do.

Altogether this is a most attractive set of science books to have in each classroom. The nineteen science areas covered afford the classroom teacher and the pupils a wide selection of science topics.

Each booklet has been written with the classroom situation definitely in mind. The reviewer gives this series his highest recommendation for the science classroom bookshelf. And the price is such that each classroom can individually afford this reference science library.

HORKHEIMER, MARY FOLEY, AND DIFFOR, JOHN W. *Educators Guide to Free Filmstrips.* Randolph, Wisconsin: Educators Progress Service, 1959. 191 P. $6.00.

This is the eleventh edition of a compilation first published in 1949. It lists 743 titles, including 94 sets of slides. (In 1946 only 82 free filmstrips were available—quite a growth!) All new titles (11) are starred. Thirty-seven filmstrips may be retained permanently by the borrower. There are some 93 titles attributed to science, but a number of more are marginal. Seven sets of slides are listed under science.

The Guide has been made most practical for use by teachers. There is a Table of Contents followed by chapters on how to use filmstrips and your filmstrip guide, suggestions for booking free filmstrips, and accident prevention and safety. Then follows a listing of filmstrips by subject, a title index, a subject index, and a source and availability index. There is a brief description of each filmstrip.

SCHWARTZ, JULIUS, AND SCHNEIDER, HERMAN. *Growing Up with Science Books.* New York (62 West 45th Street): R. R. Bowker Company, 1959. 36 P. $0.10 (100 copies $3.35).

Two hundred outstanding science books for children of all ages are listed and fully annotated.

The books selected cover a broad range of ages and subjects. Beginning with picture books for the youngest, the list offers a selection of titles that introduce the child to the wonders of the world around him—the seasons, animals, rain, etc. The twelve-to-fifteen year old list has 60 different titles and finally there are 28 selected science favorites for young adults. Science fiction and elementary science readers are not included.

Unfortunately every elementary teacher and school librarian will not learn about this wonderful bibliography, available at an almost giveaway price!

ROCKCASTLE, VERNE N., AND GORDON, EVA L. *Science Books for Children.* Ithaca, New York: Cornell Rural School Leaflet, 1957. 64 P.

This is an annotated bibliography of slightly less than two hundred fifty books suitable for

NEGATIVE tropism

It happens in the best of classes—

even with the best of teachers.

If your maximum class response isn't positive,

perhaps you need to change your stimulus.

The right stimulus makes all the difference

in the living world . . .

And the right stimulus is the right text . . .

And the right text is

Kroeber, Wolff, Weaver

BIOLOGY
1960 EDITION

for 9th or 10th grade.

D. C. HEATH and Company

Your Heath sales representative can tell you about other outstanding Heath texts in physics, chemistry, and earth science . . . and about the new program in high school physics being prepared at M.I.T. for publication by D. C. Heath and Company in time for classroom use this Fall.

elementary school children published in 1950–57. Textbook series, biographies, and books on camping have been omitted. Only books personally examined by the authors have been included.

Books are listed alphabetically by titles and also as to grade placement. The annotation that follows each title is intended to provide enough information to help in selection of books for purchase or for loan from libraries.

Books selected have been grouped under the following subject headings: General Nature Study, Animal Life in General, Mammals, Birds, Reptiles, Amphibians and Fish, Insects and Other Invertebrates, Plant Life, Earth Science, and Physical and Chemical Forces and Their Applications.

HUBER, MIRIAM BLANTON (Editor). *Story and Verse for Children.* New York (60 Fifth Avenue): The Macmillan Company, 1958. 812 P. $6.25.

This is a selection of story and verse for children from all of the writings of the past. Many are old, many familiar, some are new, some unknown.

The first seventy-four pages discusses books and children-types of stories, early books for children, illustrated books, selecting books for children, children's interests in reading, and reference books for children.

Then follow sections devoted to Mother Goose Rhymes, Verse, Fairies and Make-Believe, In Feathers and Fur and Such, The World and All, For Fun, Roads to Anywhere, The Day's Work, Our Country, Guideposts, Stories in Verse, Old Tales and Legends, Make-Believe Stories, and Stories Then and Now. At the close of each section, the story or verse is listed as to recommended grade level. There is also a list of additional stories, verse, or books.

A section is devoted to authors and illustrators. The Newberry Medal Books and the Caldecott Medal Books are listed by year of award. A key of pronunciations is also provided. The book is completely indexed.

This is a fine book for every elementary teacher to have. She will have available a wonderful source of material for classroom use. Parents, too, could very profitably have a copy available for the children and themselves!

BLOUGH, GLENN O. *Who Lives in This House?* New York (330 West 42nd Street): Whittlesey House, McGraw-Hill Book Company, 1957. 48 P. $2.50.

Who Lives in This House is a story of animal families. It is another title in the famous Blough Whittlesey House Books: *The Tree on the Road to Turntown; Not Only for Ducks: The Story of Rain; Wait for the Sunshine: The Story of Seasons and Growing Things; Lookout for the Forests: A Conservation Story; and After the Sun Goes Down: The Story of Animals at Night. Who Lives in This House* should prove equally popular. Illustrations in color and black and white by Jeanne Bendick add much to the interest and attractiveness of the book.

The old house is not as empty as it seems. Robins, wasps, squirrels, bees, skunks, and spiders live here (what, no mice or rats?).

Primary and intermediate grade children will thoroughly enjoy reading this book and having it on their elementary science bookshelf.

PRESTON, RALPH C. *Teaching Social Studies in the Elementary School.* New York (232 Madison Avenue): Rinehart and Company, 1959. 382 P. $5.00.

This is the second edition of a textbook first published in 1950. Eleven printings were made of the first edition. Some new additions and deletions have been made and the bibliography brought up to date.

Altogether this is a very fine social science methods book written by one of America's most noted elementary education teachers.

GRUMME, MARGUERITE. *Basic Principles of Parliamentary Law and Protocol.* St. Louis, Missouri (3830 Humphrey Street): Marguerite Grumme, 68 P. $1.00.

This is a Basic Manual of parliamentary procedures which will be of great value to experts and beginners alike. The usage of a slightly less than 100,000 copies attest the value many persons have found in this handy reference. The author is a registered parliamentarian and has served as a parliamentarian at many noted meetings.

BENDICK, JEANNE. *What Could You See?* New York (330 West 42nd Street): Whittlesey House, McGraw-Hill Book Company, 1957. 32 P. $2.00.

What Could You See is an adventure in looking. And you could see a lot if you were on a desert island, if you were a wilderness scout going through a great, uncharted forest, if you were a pilot in space, if you were a ranger keeping a weather station on a high mountain, if you were a prospector digging for gold, if you were a mighty hunter for a zoo, if you were a farmer, or if you were the captain of a full-rigged ship. That's what the boy and girl in this excellently written and illustrated story find out. Superb illustrations by the author supplement the textual material.

The book will delight primary grade children. They will always be getting it to read, if it's on the primary science bookshelf.

ATKIN, J. MYRON AND BURNETT, R. WILL. *Air, Winds, and Weather; Electricity and Magnetism.* New York (232 Madison Avenue): Rinehart and Company, Inc., 1958. 58 P. $1.00 each.

The above two titles are the first in a series of such pamphlets in the *Rinehart Elementary*

School Science Activities Series. The plan is the same for each pamphlet. There is a scope and sequence chart of concepts, listed according to grades. The following section gives an overview of the unit—subject matter content. There follows a section on demonstrations, experiments, and other activities. These are listed according to grade level. The latter comprise the major part of the pamphlet. There is a brief list of teacher and pupil references.

These pamphlets should prove to be of very great use to teachers of elementary science. They are highly recommended by the reviewer to every active and prospective teacher of elementary science.

The Wonder of Water. Des Moines, Iowa (838 Fifth Avenue): Soil Conservation Society of America, 1957. 15 P. $0.20.

This is a cartoon-style booklet similar to its predecessor, *The Story of Land.* More than a million copies of the latter booklet have been sold. This booklet should prove equally popular. The color cartoons will have wide appeal for elementary grade and junior high school level pupils. The factual material seems to be quite accurate.

CASTLE, JANE. *Peep-Lo.* New York (8 West 13th Street): Holiday House, 1959. Unpaged. $2.50.

Peep-Lo, suitable for six-to-nine year olds, is an excellent introduction to ornithology. Jill, noticing the odd behavior of a plover mother at the seashore, reacts with a child's quick, venturesome curiosity. By so doing, she engages in some spontaneous field work on her own.

This Beginning-to-Read book is illustrated in color by the author. The reviewer recommends it as a fine book for primary grade children.

OBOURN, ELLSWORTH S. *Analysis of Research in the Teaching of Science July 1955–July 1956.* Washington, D. C. Superintendent of Documents, U. S. Government Printing Office, 1958. 55 P. $0.25.

By and large this pamphlet is a duplication of the Fifth Annual Review of Research in Science Teaching appearing in the December 1957 issue of *Science Education.* This appearance in pamphlet form will make the report available to many more individuals and, to many in a more usable format.

SHAPP, MARTHA GLAUBER. *Planning and Organizing Science Programs in Elementary Schools.* New York (2 West 45th Street): The Grolier Society, 1958. 80 P.

This teacher's guide is designed for use in conjunction with *The Book of Knowledge.* The author is Curriculum Coordinator in the Bureau of Curriculum Research of the New York City Public Schools.

The booklet, organized around seven broad topics in elementary science, is intended to give the teacher an overview of the scope of science in grades kindergarten through six.

Areas include: Weather, Living Things Around Us, Our Earth, Beyond Our Earth, Magnetism and Electricity, Transportation, and Communication.

For each unit there is an overview, basic concepts to be developed, things to do, experiments, content, and cross references for each grade level to specific references in *The Book of Knowledge.*

Such an arrangement, a complete Teacher's Guide and a complete source of reading material is unique in elementary science. Many teachers can take immediate advantage of this fine opportunity to improving their elementary science teaching and many more teachers will be intently desirous of doing so.

SCHREIBER, ROBERT E. *Improving the School's Audio-Visual Program.* De Kalb, Illinois: Educational Bulletin Service, Northern Illinois University, 1958. 23 P. $0.25.

This handbook for teachers and administrators is one of a number of publications on a variety of educational topics.

This particular monograph discusses the scope, objectives, and effective operation of the audio-visual program and the selecting, using, and evaluation of audio-visual materials.

Elementary and secondary teachers will find numerous helpful suggestions in this monograph.

NEURATH, MARIE. *Too Small to See.* New York (121 East 24th St.): The Sterling Publishing Co., Inc., 1956. 36 P. $2.50.

Have you wondered how the cat can stay so clean? How the fly cleans itself? What about the shopping basket of the honey bee? Why the bee's sharp sting means its death? Why does the mosquito bite? These questions and others are answered in this small book by means of attractive colored pictures.

The book is recommended for eight to twelve year olds and for the elementary school science bookshelf.

HYDE, MARGARET O., AND KEENE, FRANCES W. *Hobby Fun Book.* Pelham, New York: The Seahorse Press. 128 P. $1.00.

Intended for grade school boys and girls this *To-do Hobbies* covers such diverse subjects as indoor gardens, air, chemistry, electricity, water, paper, pets, color, block printing, and so on. The creative hobbies afford an excellent opportunity for integrating a number of learning areas. The book is abundantly illustrated. Altogether this is a fine book for any elementary level teacher to have in her classroom.

Prehistoric Animals. Darien, Connecticut: The Educational Publishing Corporation, 1959.

Thirty-two outline drawings of prehistoric mammals, birds, dinosaurs, and fish make up this activity booklet. Children will love to color the drawings. The drawings may be traced for multiple copies. A brief description of each animal to be colored is found on the inside book covers. Children will love to color the prehistoric animals and teachers will appreciate the outline drawings for use in duplications.

FRITZ, JEAN. *How to Read a Rabbit.* New York (210 Madison Avenue): Coward-McCann, Inc., 1959. Unpaged. $2.50.

Stephen thought the Animal Lending Library was a place where animals could take out books. Actually it was a library which lent animals to children instead of books. (There are many such libraries across the country!) A delightful story for five to nine year olds is built around this theme. There are black-and-white illustrations by Leonard Shortall.

GABBARD, BESSIE, AND RAIRDEN, LOUISE. *Primary Grade Activities.* Chicago (Merchandise Mart Plaza): Field Enterprises Educational Corporation, 1957. 145 P. $1.00.

This booklet indicates various ways that primary grade teachers have found *The World Book Encyclopedia* especially helpful. The activities and practices have been used under typical conditions in five school systems. There is a wide range and variety of activities in the various areas of learning including much from the science area. Activities are listed according to kindergarten, first grade, second grade, and third grade levels.

Teachers who do not have access to *The World Book Encyclopedia* will find the book replete with suggestive ideas.

CONTENTS

(Continued from inside front cover)

ER
ss

d"

re!

pencer
bution

cer's Co-
eethoven

complete
ecord of-
tative or
Spencer's
" and see
l library.

cyclopedia

s portray
ls against
her lands.
adult en-
t was the
n illustra-
terseness,
am of its
ork from
eeds and

ois

ON